Graymark®

523 Strobe Light

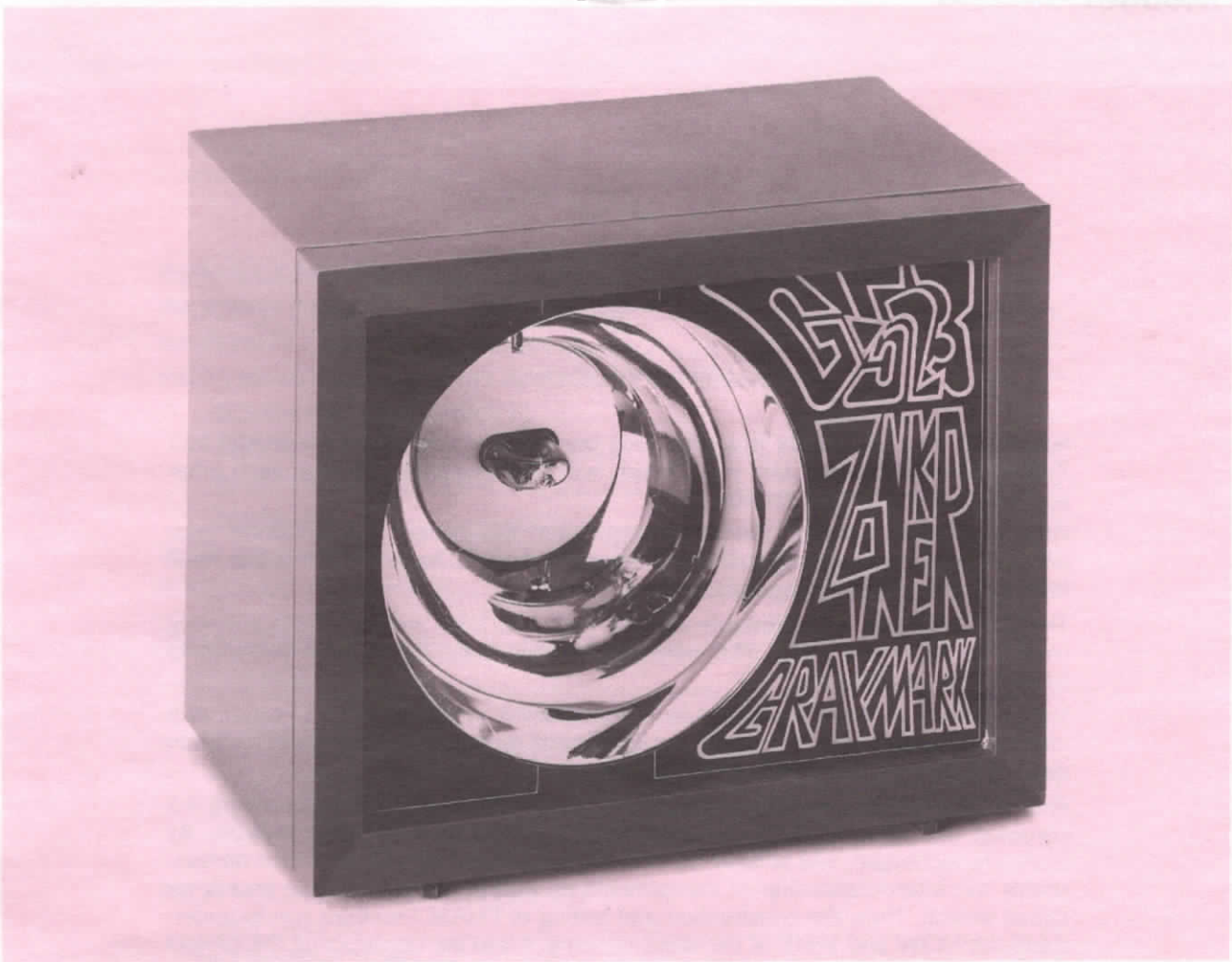
By

GRAYMARK INTERNATIONAL, INC.

SUBSIDIARY OF BUCK ENGINEERING CO. INC.

Printed in U.S.A.

61929-5



ZONKER

Strobe Lite

Model 523

Prepared by the Staff of Graymark International, Inc.
Educational Contributions by Austin Lucero

INTRODUCTION

Success at your next party is a sure thing once you've completed the Model 523 Zonker Strobe Lite! You and your friends will be fascinated watching each other seemingly dance in slow motion.

With more than 500,000 flashes of inspiration, the Zonker can transform your entertainment into a groovy and imaginative psychedelic happening. It is also ideal for creating exciting photographic effects.

The Zonker flashes are adjustable to rates from 1 to 5 per second—from a teasing twinkle to a powerful pulse. The many uses for this strobe light will be limited only by your own imagination.

Your Model 523 Zonker Strobe Lite is constructed in three PHASES, which will allow you to experience several fun-filled and meaningful experiments and to develop hands-on experience working with a xenon flash tube.

PHASE I consists of constructing the unit in a breadboard form. Breadboarding is a common technique used by electronic engineers and technicians in industry. By using this technique, you achieve an over-all assembly of the circuit, which demonstrates the inter-relationship of components as well as gives you easy access for circuit testing. Thus, the construction and testing of PHASE I enables you to understand the HOW and WHY of the unit's circuitry. If you are constructing this project without the supervision of an instructor, you may omit PHASE I and go directly to PHASE II.

PHASE II is, industrially speaking, the assembly line operation. This phase is concerned with arranging the components and fittings onto the printed circuit board (PCB). This phase will provide you with several experiences, such as component identification, component mounting, solder techniques, lead dress, and final assembly of the PCB within the plastic cabinet.

PHASE III provides you with operation instructions, product specifications, learning experience review, and review evaluation.

At the back of the book is a section on servicing and parts replacement, which gives a Service Flow Chart for your use in trouble-shooting problems and gives information on ordering replacement parts and/or factory servicing.

You are now ready to start constructing your Model 523 Zonker Strobe Lite. Follow the instructions closely and you will have a worthwhile project, one that you can be proud of and one that you will have fun assembling.

TABLE OF CONTENTS

PROGRESS GUIDE

The purpose of this Progress Guide is to allow you to keep an accurate record of your progress in constructing and understanding the basic electronic fundamentals contained in the Zonker. To develop this basic understanding, be sure to assemble this project in the sequence outlined below. Do not proceed to the next experience until the previous one is fully understood.

If the Zonker is being built for a school project, you should obtain your instructor's initials at the completion of each learning experience. The Final Evaluation is provided so that your instructor can indicate your degree of achievement on the entire project.

*Your Name:*_____

YOUR INITIALS	COMPLETION DATE	LEARNING EXPERIENCE	EVALUATION	INSTRUCTOR'S INITIALS
		PARTS IDENTIFICATION AND INVENTORY EXPERIENCE		
		WARRANTY CARD REGISTRATION		
		SOLDERING EXPERIENCE		
		PHASE I BREADBOARD		
		VOLTAGE DOUBLER CIRCUIT EXPERIENCE CONSTRUCTION		
		INSTRUMENTATION AND MEASUREMENT		
		HIGH VOLTAGE CIRCUIT CONSTRUCTION		
		INSTRUMENTATION AND MEASUREMENT		
		PHASE II PRINTED CIRCUIT BOARD ASSEMBLY		
		CONSTRUCTION EXPERIENCE		
		CIRCUIT TEST		
		CABINET ASSEMBLY		
		PHASE III EVALUATION		
		REVIEW EVALUATION		
		FINAL EVALUATION		

PARTS IDENTIFICATION AND INVENTORY EXPERIENCE

This experience is provided to acquaint you with the various electronic components and fittings included in the model **523** project. Unpack the project carefully and check (√) each part and fitting against the PARTS LIST on page 9. In case of incorrect, missing, or damaged parts, please refer to How to Order Replacement Parts on page 30 and Graymark's Warranty on page 31.

To assist you in proper identification of the major parts and fittings, pictorial and schematic illustrations are given in Figures 1, 2 and 3 and other information on page 8. Upon completion of the parts identification and inventory, have your instructor initial your Progress Guide.

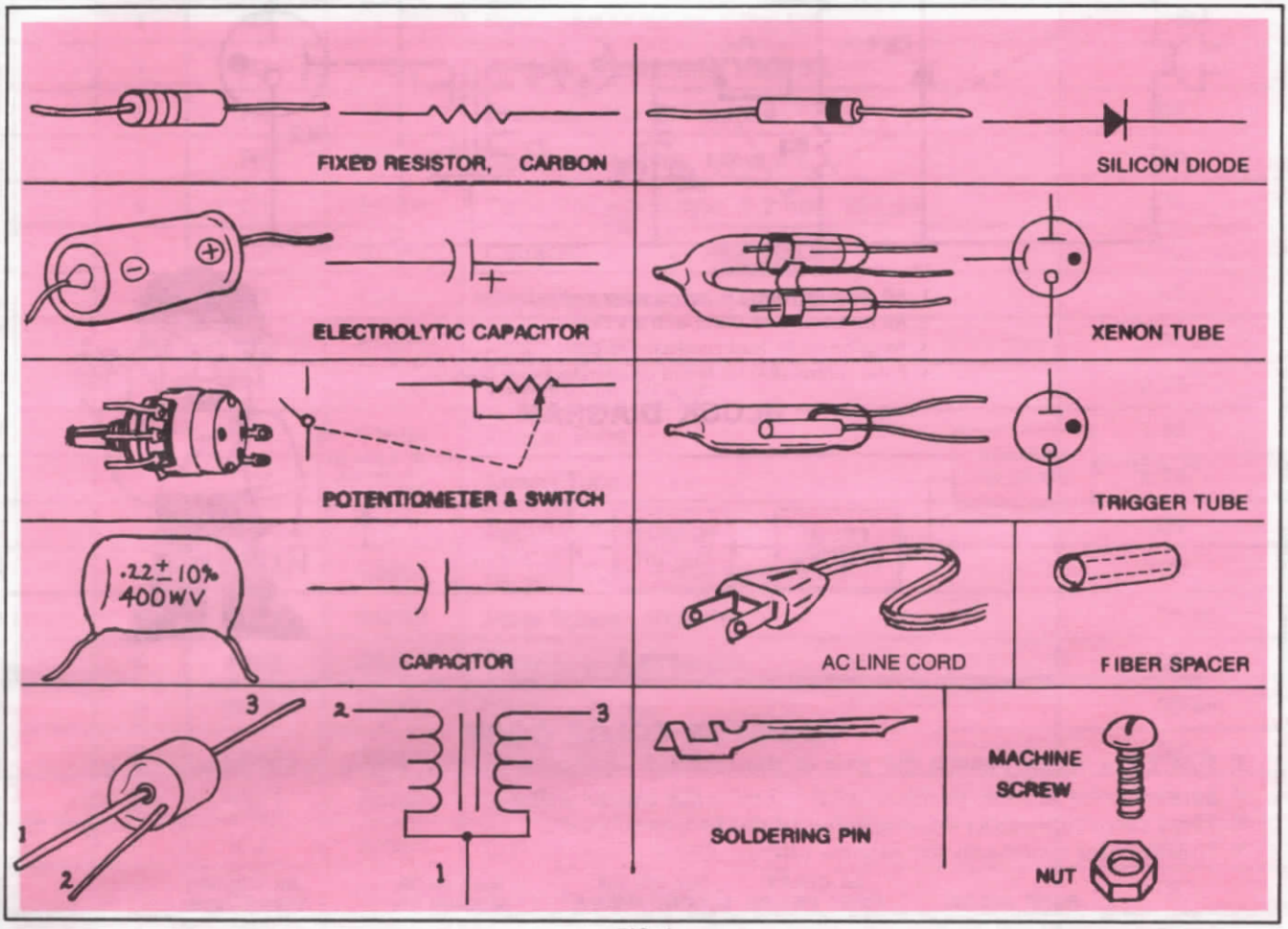


FIG. 1

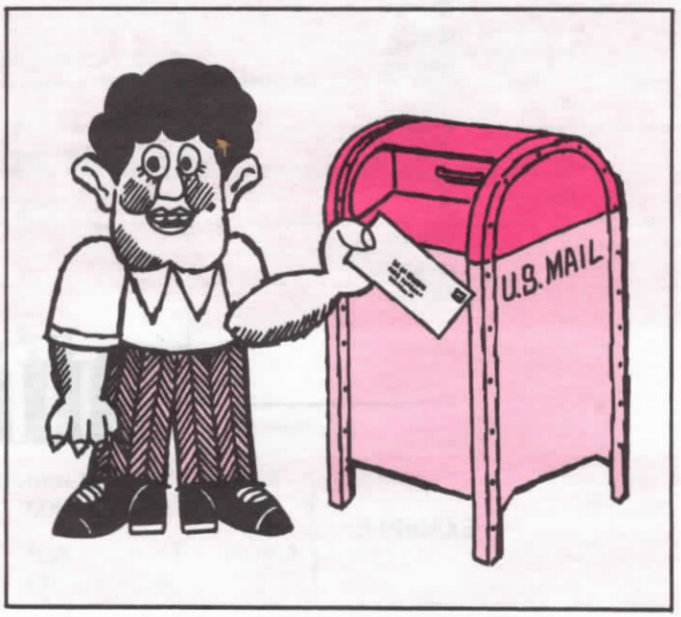
WARRANTY CARD REGISTRATION

IMPORTANT: For your project to be covered by the Factory Warranty, as shown on page 31, you must accurately fill out the enclosed WARRANTY CARD and mail it to Graymark within 10 days of date of purchase.

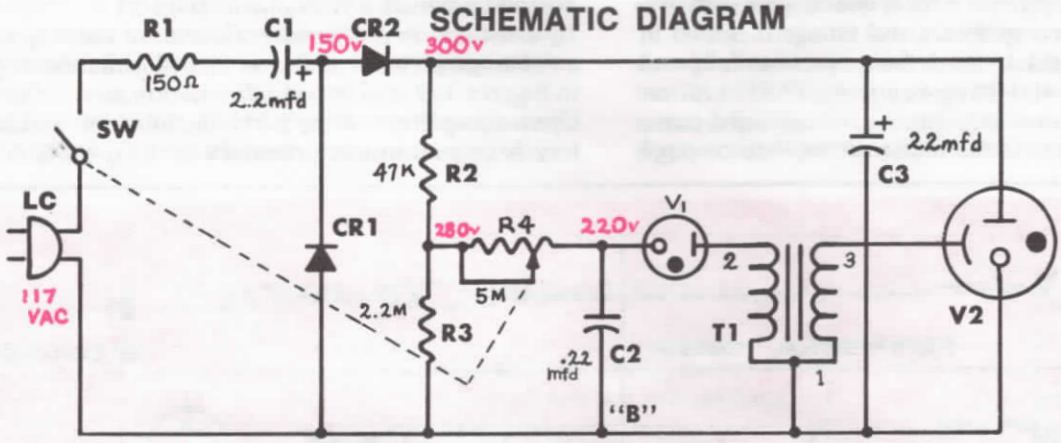
Before mailing, be sure the card gives your name, address, date of purchase, and the project model number (523) that this warranty card covers. To assist Graymark in making available products that interest you, please take a moment and list on the card additional projects you would like us to develop.

1. *Fill out warranty card and tear off.*
2. *Retain remainder of card for your records.*
3. *Mail warranty card immediately.*

Upon completion and mailing of warranty card, have your instructor initial your progress Guide.



SCHEMATIC DIAGRAM



Measurement Conditions

1. All measurements DC unless otherwise indicated.
2. All measurements made with a VTVM.
3. Negative meter lead connected to point "B."
4. Pulse control (R4) set in full counterclockwise position.

BLOCK DIAGRAM

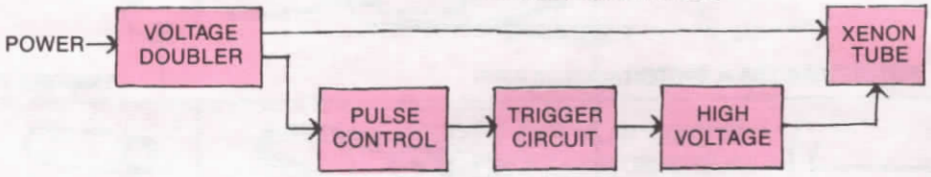


FIG. 2

RESISTOR COLOR CODE

- First color (color nearest the end of the resistor) represents the first figure in the resistor value.
- Second color represents the second figure in the resistor value.
- Third color represents the multiplier of the first two figures.
- Fourth color represents the resistor tolerance.

BAND COLOR	1st COLOR FIRST FIGURE	2nd COLOR SECOND FIGURE	3rd COLOR MULTIPLIER	4th COLOR TOLERANCE
NO COLOR	—	—	—	20%
SILVER	—	—	.01	10%
GOLD	—	—	.1	5%
BLACK	0	0	1	
BROWN	1	1	10	
RED	2	2	100	
ORANGE	3	3	1,000	
YELLOW	4	4	10,000	
GREEN	5	5	100,000	
BLUE	6	6	1,000,000	
VIOLET	7	7	10,000,000	
GRAY	8	8	100,000,000	
WHITE	9	9	1,000,000,000	

EXAMPLE:

Red	Violet	Orange	Silver
2	7	000	10% = 27000 or 27K ohm, 10%
Green	Blue	Red	Silver
5	6	00	10% = 5600 or 5.6K ohm, 10%

PARTS LIST
Model 523 Zonker

(✓)	QTY.	SYMBOL	PART NO.	DESCRIPTION	REPLACEMENT PRICE
	1	R1	62328	Resistor, 150 ohms, 5w, 20%	$ .20
	1	R2	61376	Resistor, 47K ohms, 1/2w, 5%	.10
	1	R3	61395	Resistor, 2.2M ohms, 1/2w, 5%	.10
	1	R4	62808	Potentiometer, 5M ohms	.90
	1	R5	61390	Resistor, 22 ohms, 1/2 w, 5%	.10
	1	C1	62876	Capacitor, electrolytic, 2.2 mfd, 350 wv	.30
	1	C2	61334	Capacitor, film, .22 mfd, 400 wv	.50
	1	C3	62877	Capacitor, electrolytic, 22 mfd, 450 wv	.65
	2	CR1,CR2	61331	Diode, silicon	.45 ea.
	1	T1	61038	Transformer, trigger	2.75
	1	V1	61654	Trigger Tube	1.45
	1	V2	61655	Xenon Tube	4.75
	1	PCB	61636	Printed Circuit Board	.85
	1	LC	63964	AC Line Cord, with plug & switch	.75
	2	FS-1	61259	Fiber Spacer, shoulder	.05 ea.
	1	FS-2	61447	Fiber Spacer, 1" length	.05
	2	MS-1	63639	Machine Screw	.05 ea.
	2	MS-2	61281	Self-Tapping Screw	.05ea.
	2	MSN	62909	Machine Screw Nut	.05 ea.
	1	CK	62555	Control Knob, round	.25
	1	HW1	62724	Buswire, bare copper	.05
	1	SR	63735	Solder, rosin core 60/40	.65
	15	SP	61357	Soldering Pin	.05 ea.
	1	PC	61893	Plastic Cabinet, with reflector	10.00
	1	RP	61091	Rear Panel	.25
	1	BBB	61894	Breadboard Base, with schematic	.40
	1	---	61929	Instruction Manual	3.00

TOOL REQUIREMENT

Illustrated in Fig. 4 are the tools necessary to assemble your project. Additional tools, such as nut drivers, pliers, and soldering aids, make circuit assembly easier, but are not required.

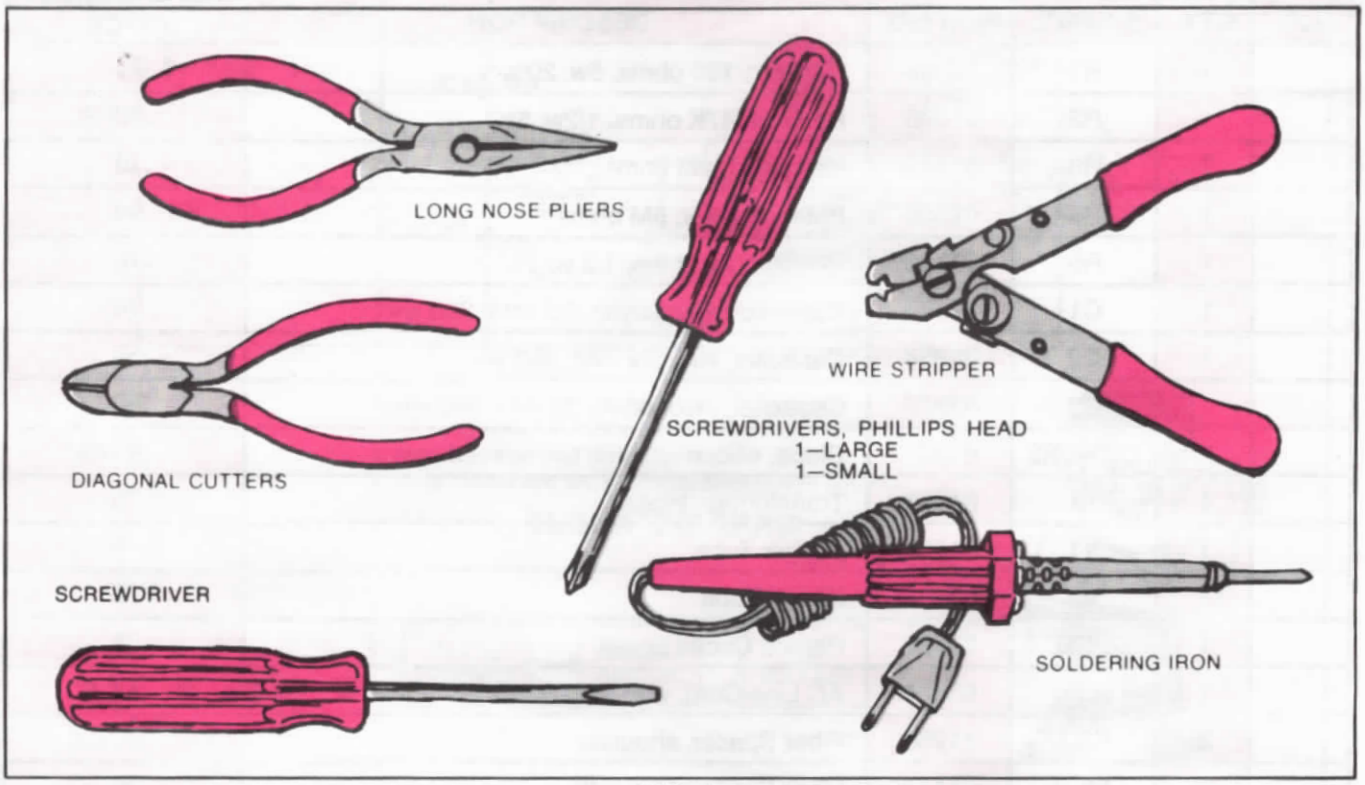


FIG. 4

SOLDERING EXPERIENCE

For this project to work properly, you must have good solder connections. If you have not had experience in soldering, it is suggested that before you start assembling this project, you practice making solder connections with odd lengths of wire and used components. Observe the following rules for proper soldering techniques.

1. **Use a 30-to-50-watt pencil type soldering iron.** Do not use a soldering gun.
2. Use only rosin core solder as supplied with your project. The use of any other types of solder will void your warranty. If additional solder is required, use only 60-40 rosin core, such as Kester 44. DO NOT USE ACID CORE SOLDER or paste fluxes.
3. Be sure the tip of the iron is well tinned (coated with a thin layer of molten solder) so that it will properly conduct heat. To keep the tip clean, wipe it from time to time with a damp sponge or cloth. (See Fig. 5.) Do not clean on a sal ammonia block.
4. Before soldering, be sure all connection points such as wire leads, terminal lugs, and printed circuit (p.c.) islands are clean and free of oxidation. Tin wire leads before connecting them into the circuit.
5. Whenever possible, attach wire leads onto terminal lugs by forming tight mechanical connections before you apply solder.
6. Wear safety glasses while unsoldering and soldering to avoid eye injury caused by a hot solder splash or flying bits of wire leads.
7. Position the flat side of the soldering iron firmly against the wire lead and terminal to preheat the metal parts to be soldered. (See Fig. 6.) CAUTION: **When soldering semiconductors, such as transistors, use a heat sink to prevent damage to these heat-sensitive devices.**
8. While the connection is being heated, apply the solder. Do not apply the solder directly onto the tip of the iron. Remove the solder feed when enough molten solder has been applied to form a thin coating on all metal parts in the connection. (See Fig. 7.)
9. After the solder feed has been removed, continue to heat the connection for an INSTANT...this will aid the flow of molten solder and insure against flux pockets. Next, remove the iron from the connection in a smooth motion.
10. Wait until the solder has cooled (solidified) before testing the connection. A properly soldered connection will have a good fillet contour and a smooth bright finish. (See Fig. 8.)

Lead dress and placement of components is also important. All wiring or parts placement should be as neat as possible. See Fig. 9, 10, 11, and 12 for examples of component placement and solder connections.

Have your instructor initial your Progress Guide.

CLEANING TIP

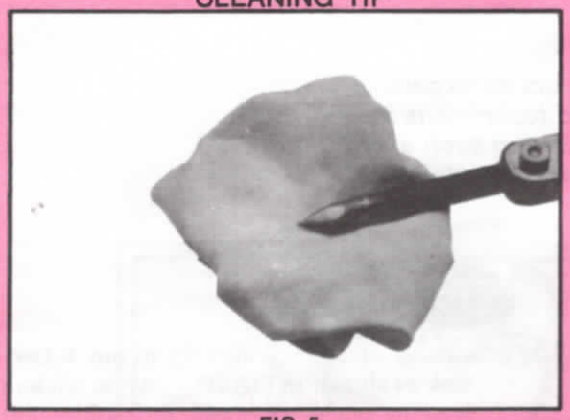


FIG. 5

PREHEAT

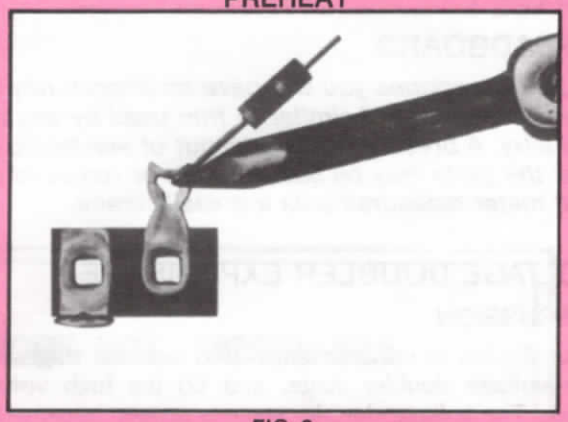


FIG. 6

APPLYING SOLDER

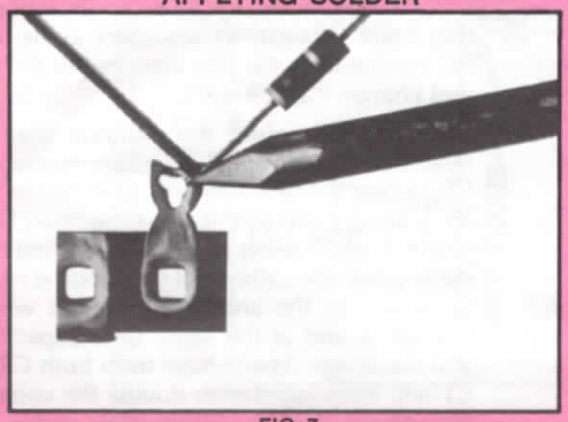


FIG. 7

SOLDER FLOW

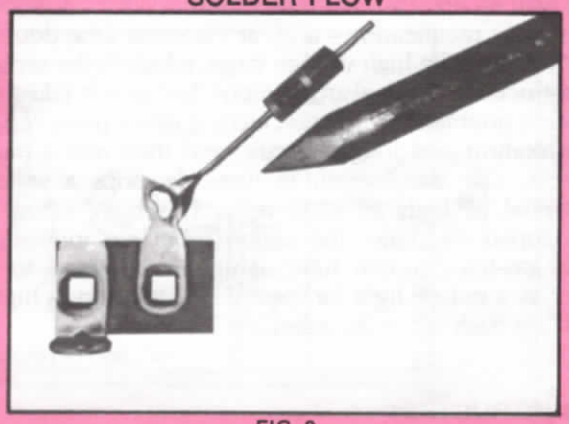


FIG. 8

CORRECT

FIG. 9

INCORRECT

FIG.10

CORRECT

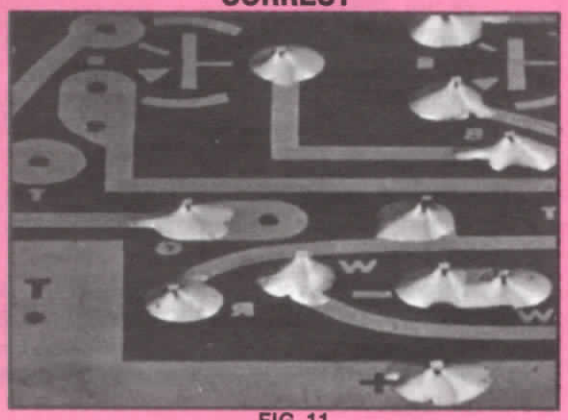


FIG. 11

INCORRECT

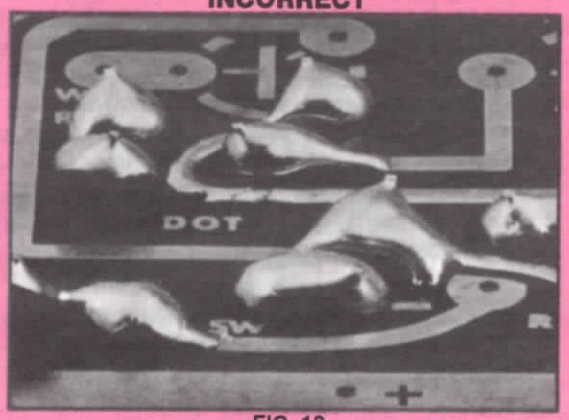


FIG. 12

PHASE I

BREADBOARD

In this experience you will have an opportunity to construct an experimental breadboard similar to that used by engineers and technicians in industry. A breadboard is a layout of electronic parts, wired in such a way that the parts may be easily added or removed during experimental work, and meter measurements are easily made.

VOLTAGE DOUBLER EXPERIENCE

DISCUSSION

Your Zonker is constructed in two separate stages: (1) the voltage doubler stage, and (2) the high voltage stage. The voltage doubler stage is unique because the circuit changes the alternating current (AC), taken from the wall receptacle, into direct current (DC)—a process known as rectification—and, at the same time doubles the voltage. The high voltage stage, which is the second construction stage, also is unique because it takes the already doubled DC voltage, feeds it into a pulse repetition control and trigger circuit, and then into a transformer. The transformer, in turn, develops a voltage potential as high as 4000 volts. This high voltage is developed to trigger the xenon tube into ionization. This gas-filled xenon tube, which is designed to be used as a pulsed light for special effects, yields a highly brilliant flash when its gases are ionized.

CONSTRUCTION

The polyurethane panel, with the Zonker schematic diagram attached, will serve as a breadboard base (See Figure 13) upon which you will construct your experimental circuits. DO NOT CUT THE LEADS of any components unless instructed to do so, because these components will be used for constructing other circuits.

____1. Separate eight pins from the soldering pin strips as shown in Figure 14.

____2. Push a soldering pin into the breadboard panel at X marks 1, 2, 3, 4, 5, 12, 13, and 14 on the schematic. (Refer to Figure13).

____3. Connect and solder current-limiting resistor R1, 150 ohm, 2 watt, between pins 1 and 2. This resistor will protect the diodes CR1 and CR2 from current surges.

____4. Connect and solder the positive (+) lead (lead nearest "+" on capacitor) of the voltage doubler capacitor C1, 2.2 mfd, 350 WV, electrolytic, to pin 3. Connect and solder the other lead (-) to pin 2. (See Figure 13.) This capacitor will store a voltage charge from the line cord during one half of the AC cycle and will release this voltage during the second half of the cycle. Refer to Figure 15.

____5. Cut a 6¼-inch length of bus wire for bus wire B. Connect and solder this between pins 12, T3, and 14.

____6. Connect and solder the cathode lead (lead nearest to colored band, refer to Figure 16) of voltage doubler diode CR1 to pin 3. Use a heat sink as shown in Figure while soldering this lead in place. Connect and solder the other lead (anode) to bus wire B, again using a heat sink. During the AC cycle, when the cathode of this diode is negative, in respect to the anode, AC current from the line cord passes through it and charges capacitor C1.

____7. Connect and solder the cathode lead (lead nearest to colored band) of voltage doubler diode CR2 to pin 4. Use a heat sink as shown in Figure 17. Connect and solder the other lead (anode) to pin 3, again using a heat sink. During the AC cycle when the cathode of this diode is negative in respect to the anode, AC current will pass through it and at the same time capacitor C1 will discharge. The voltage from both CR1 and C1 will form together to double the voltage for the voltage doubler circuit. Thus, when diode CR1 is passing current, diode CR2 is blocking

____8. Connect and solder voltage divider resistor R2, 47K (yellow-violet-orange), between pins 4 and 5. R2 will work in conjunction with R3 to effectively divide the doubler's voltage, which will then be channeled for activating the trigger tube V1. (Use a heat sink on CR2 while soldering R2 to pin 4.)

____9. Connect and solder voltage divider resistor R3, 2.2M (red-red-green), between pin 5 and bus wire B. R3, when combined with R2, will divide the doubled voltage into two uneven values. The voltage appearing on R3 will charge the capacitor C2, which will cause V1 to trigger, or fire.

____10. Separate the line cord leads from each other for a distance of 2 inches from the end. (Refer to Figure 18) Strip (remove) ¼ inch of insulation from the free end of each lead. (Refer to Figure 18.)

____11. Connect and solder one lead of the line cord to pin 1. Next, connect and solder the other lead to pin 14.

____12. This completes the construction of the voltage doubler circuit. Check all your soldering connections, component placement, and wiring and compare your breadboard to the illustration in Figure 13.

____13. Have your instructor initial your Progress Guide.

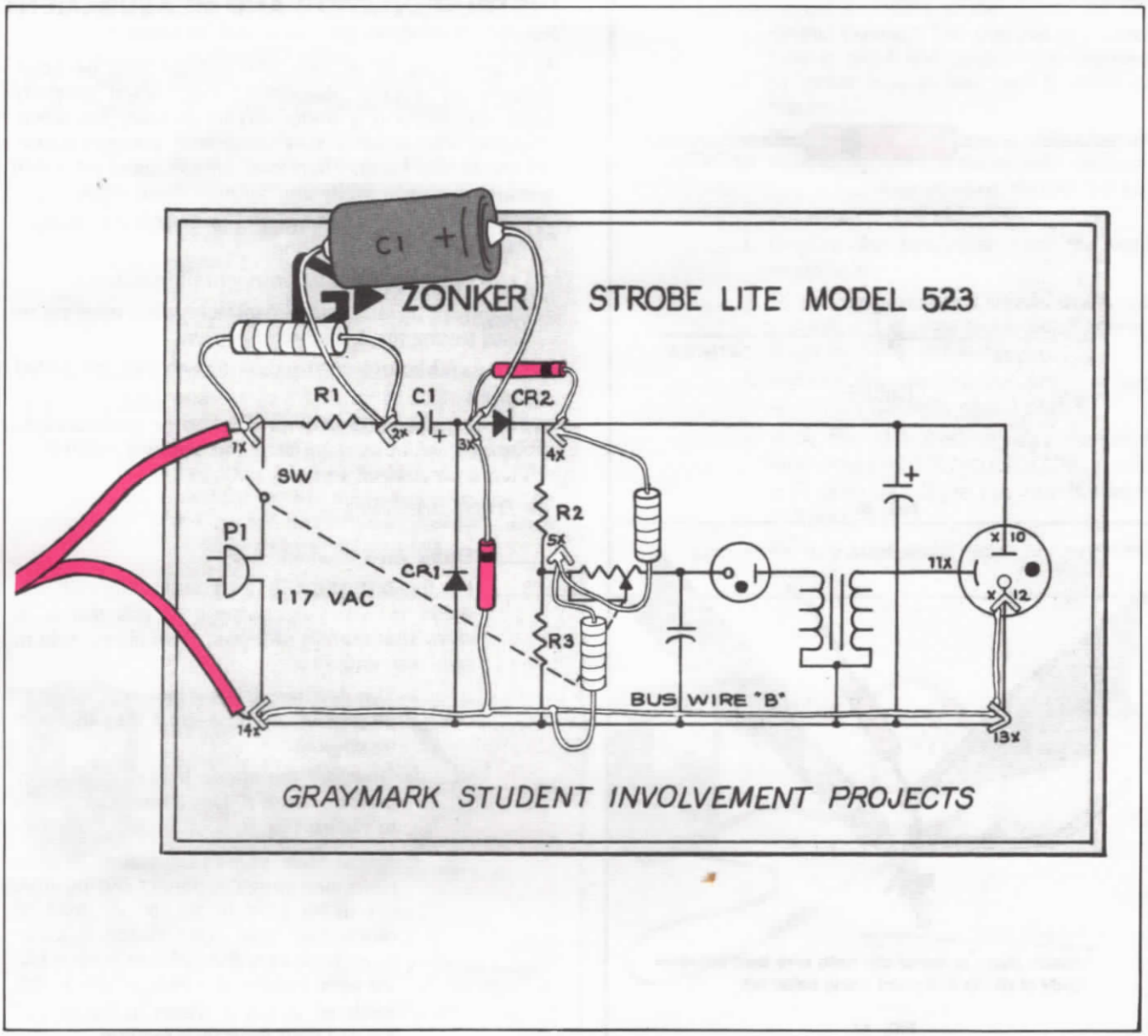


FIG. 13

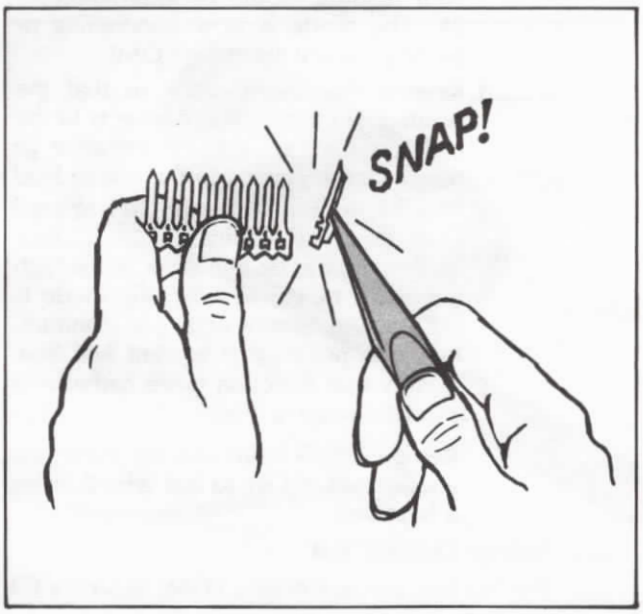


FIG. 14

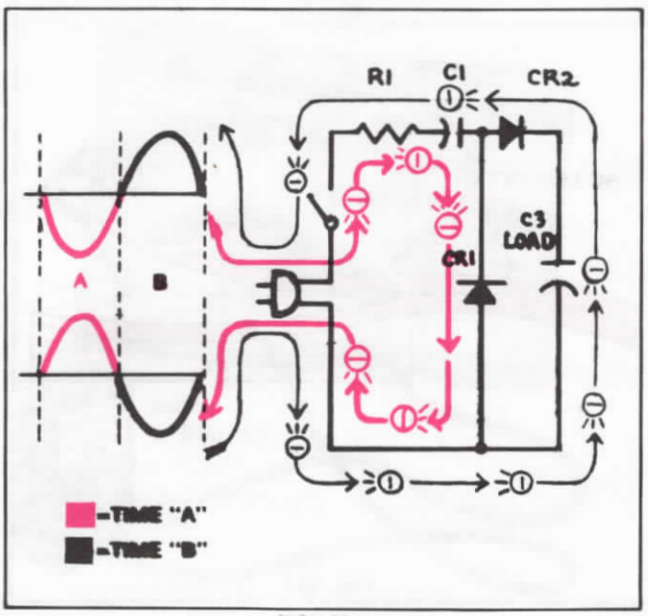


FIG. 15

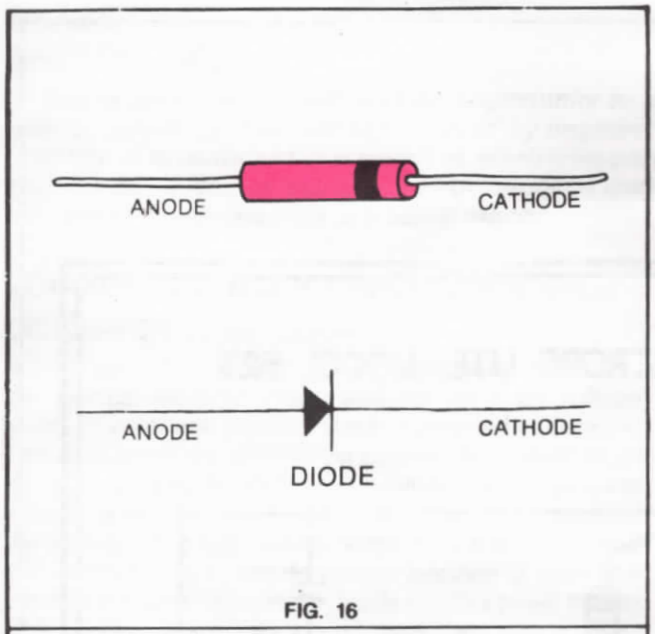
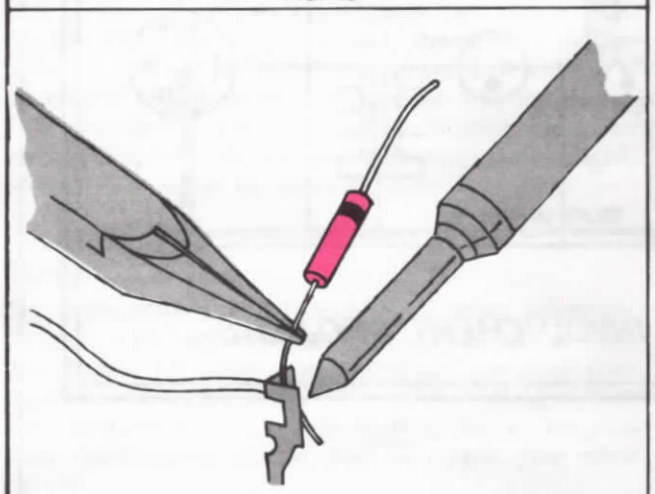


FIG. 16



Attach pliers or metal clip onto wire lead between body of diode and point being soldered.

FIG. 17

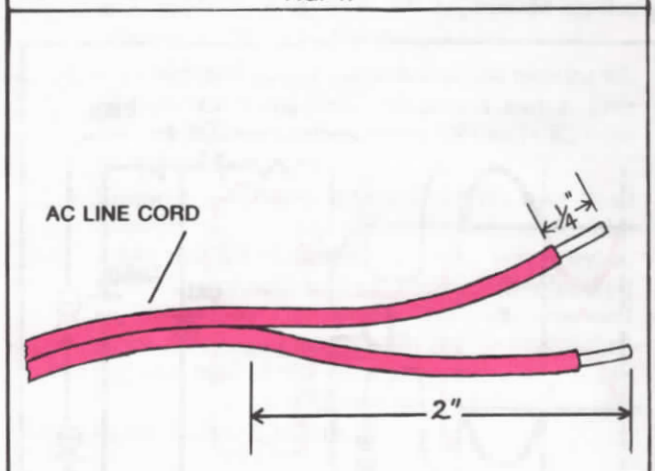


FIG. 18

INSTRUMENTATION AND MEASUREMENT

You are about to perform live voltage tests on your breadboard circuit. Remember that, when properly used, electricity is a useful servant of man, but when misused, electricity is very dangerous and can cause severe bodily harm. Therefore, always use care when working with electricity and observe these rules:

(1) Unplug circuit from power source BEFORE changing meter leads or wiring.

(2) Use only one hand when performing tests.

(3) Stand on an ungrounded surface when working on and testing the breadboard circuit.

(4) If available, use an isolation transformer for added safety.

(5) Keep the breadboard on a wood or ungrounded surface when working on it and testing it. NEVER work on a metal surface.

(6) THINK SAFETY.

_____1. Diode Measurement Test

For this test, you will need a volt-ohm-milliammeter (VOM). The purpose of this test is to show that current will pass through a diode in only one direction.

_____a. This test requires no power. DO NOT plug your AC line cord into the wall receptacle.

_____b. Unsolder the anode lead of diode CR1 from bus wire B. Use a heat sink. (Refer to Figure 19.)

_____c. Adjust your VOM to the R x 1K-ohm resistance range. Connect the positive (+) meter lead to the anode lead of diode CR1, and connect the negative (-) meter lead to the cathode lead (marked with a colored band), which is still soldered to pin 3. (Refer to Figure 19.) Record your resistance reading:_____. Your reading should be approximately 2K. The diode is now conducting or passing current (from the VOM).

_____d. Reverse the meter leads so that the positive (+) meter lead connects to the cathode (pin 3) and the negative (-) meter lead connects to the anode lead of CR1. (Refer to Figure 20.) Record your resistance reading:_____. Your reading should be infinite or in the high meg-ohm range, as now, the diode is not passing current or is non-conducting. This proves that current will flow in only one direction (from cathode to anode) through a diode.

Remove meter leads and reconnect the anode lead of CR1 to bus wire B, using a heat sink.

_____2. Voltage Doubler Test

For this test, you will need a VOM, capacitor C3

(22 mfd, 450 WV, electrolytic), and a clip lead or piece of bus wire. The purpose of this test is to prove that DC voltage can be doubled by use of diodes, without the need for large and heavy transformers or other complex circuits.

_____a. Unsolder the anode lead of diode CR1 from bus wire B (use a heat sink on the lead when reheating to unsolder). Refer to Figure 17. Bend this lead upward, away from the other components and wires.

_____b. Connect a clip lead or a piece of bus wire (bare copper) between pins 2 and 3. (Refer to Figure 22.)

_____c. Connect the positive (+) lead (lead nearest to "+") of capacitor C3, 22 mfd, 450 WV, electrolytic, to pin 4 as shown in Figure 22. Connect and solder the other lead (-) to bus wire B. The purpose of this capacitor is to provide a load for the voltage doubler circuit in order to perform this test.

_____d. Adjust the VOM to the 0-500-volt DC range. Connect the positive (+) meter lead to pin 4 and connect the negative (-) meter lead to bus wire B. Refer to Figure 22.

_____e. Plug the line cord into a 117-volt wall receptacle. Record the voltage reading: _____. Your reading should be approximately 150 volts DC.

_____f. Unplug the line cord from the wall receptacle.

_____g. To prevent a possible shock, discharge capacitor C3, using an insulated screwdriver as shown in Figure

_____h. Remove the clip lead or piece of bus wire from between pins 2 and 3.

_____i. With the clip lead or wire removed from pins 2 and 3, reconnect the anode lead of diode CR1 to bus wire B. (Refer to Figure 23.)

_____j. Be sure your meter remains connected

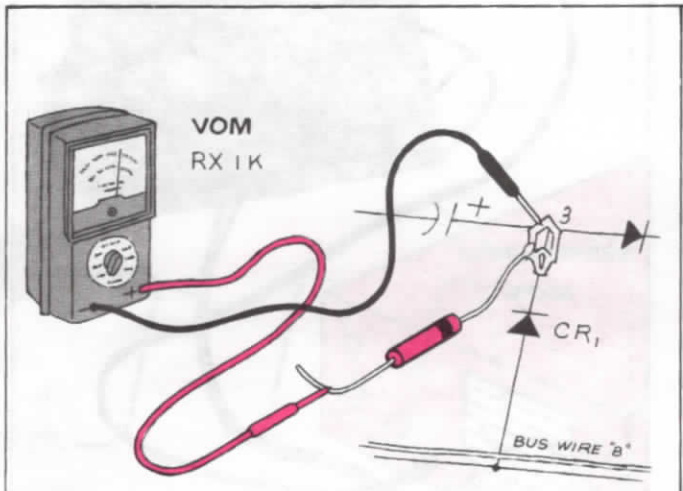


FIG. 19

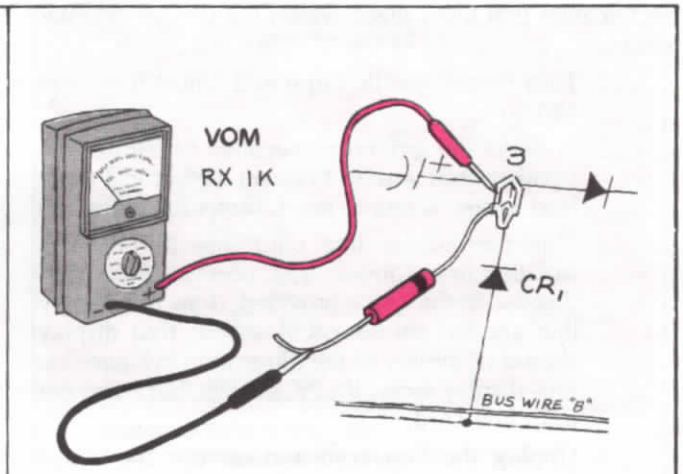


FIG. 20

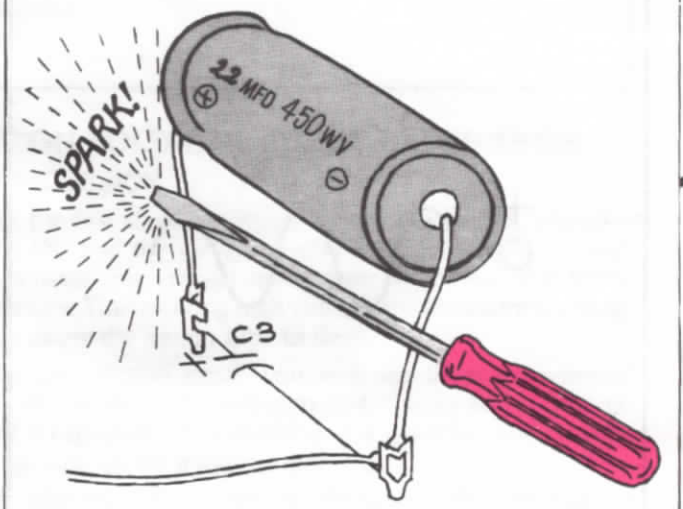


FIG. 21

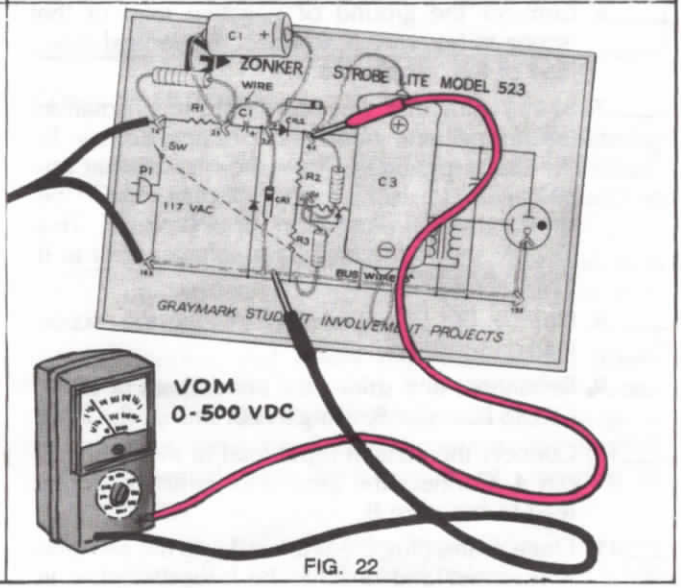


FIG. 22

as described in step d.

_____k. Again, plug the line cord into the wall receptacle. Record the voltage reading: _____. Your reading should be approximately 300 volts, or twice the previous measurement (150 volts). This proves that diode CR1, with the aid of C1, doubles the voltage.

_____l. Unplug the line cord from the wall receptacle and remove the meter leads.

_____m. To prevent a possible shock, discharge capacitor C3, using an insulated screwdriver as shown in Figure 21

_____n. Remove capacitor C3 from pins 4 and bus wire B.

_____3. Have your instructor initial your Progress Guide.

OPTIONAL EXPERIENCE

Voltage-Doubler Rectification and Transformation

For this experience you will need an oscilloscope and an isolation transformer. This experience will demonstrate the voltage transformation (increase) and the rectification that takes place within the voltage doubler circuit.

_____1. Turn on the oscilloscope and adjust it to read 150 volts.

_____2. Connect the ground or negative (-) lead of the 'scope to bus wire B. Connect the vertical input lead of the 'scope to pin 1. (Refer to Figure 24.)

_____3. Plug the Zonker line cord into the 117-volt isolation transformer, and observe the 'scope display. In the space provided, draw the display that appears on the oscilloscope. Your display should be similar to the illustration in Figure 25. This display shows the AC current that is present from line cord.

_____4. Unplug the line cord and remove the 'scope leads.

_____5. Unsolder the anode lead of diode CR1 from bus wire B. Use a heat sink on the lead.

_____6. Connect the ground or negative lead of the 'scope to bus wire B. Connect the vertical input lead of the 'scope to pin 4.

_____7. Again, plug the line cord into the isolation transformer and observe the 'scope display. In the space provided, draw the display that appears on the 'scope. Your display should be similar to the illustration in Figure 26. This display shows the half-wave voltage, prior to it being doubled.

_____8. Unplug the line cord and remove the 'scope leads.

_____9. Reconnect and solder the anode lead of diode CR1 to bus wire B, using a heat sink on the lead.

____10. Connect the vertical input lead of the 'scope to pin 4. Connect the ground or negative 'scope lead to bus wire B.

____11. Once more, plug the line cord into the isolation transformer and observe the 'scope display. In

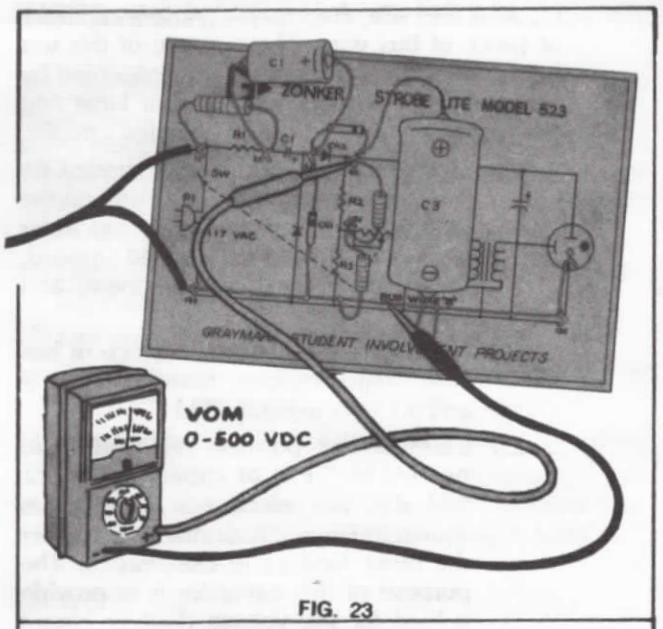


FIG. 23

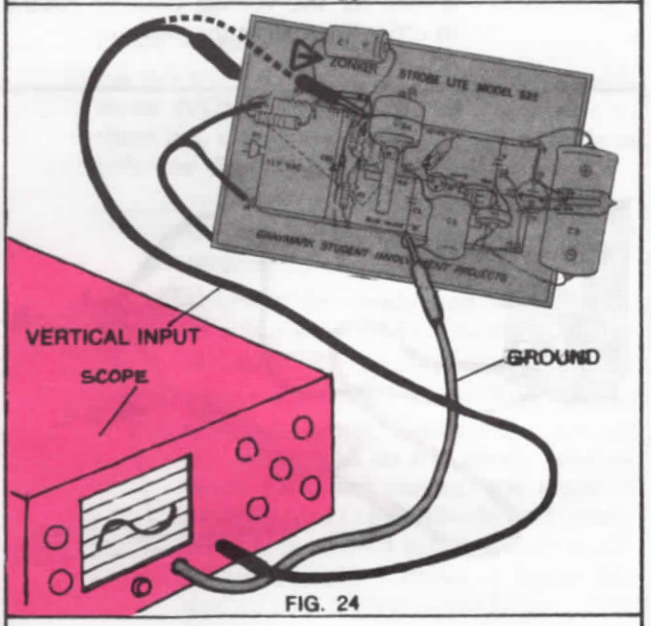


FIG. 24


FIG. 25

the space provided draw the display that appears on the 'scope. Your display should be similar to the illustration in Figure 27. This shows the voltage doubled as compared to the previous test (step 7).

____12. Unplug the line cord, remove the 'scope leads and turn off the oscilloscope.

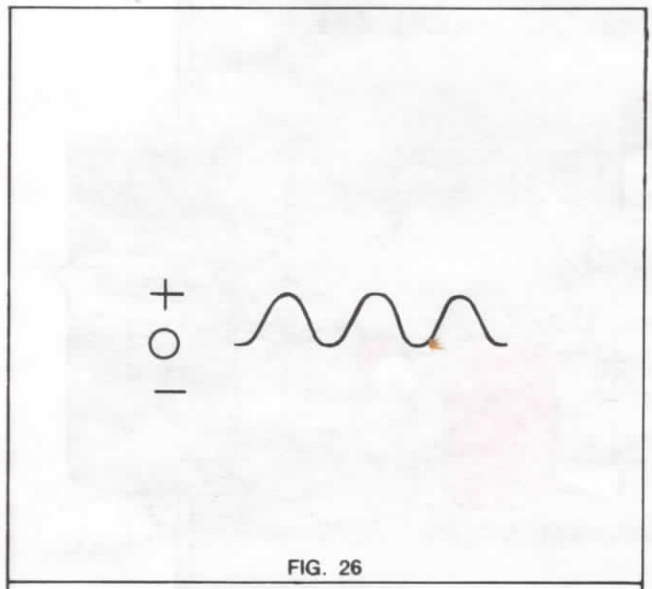


FIG. 26

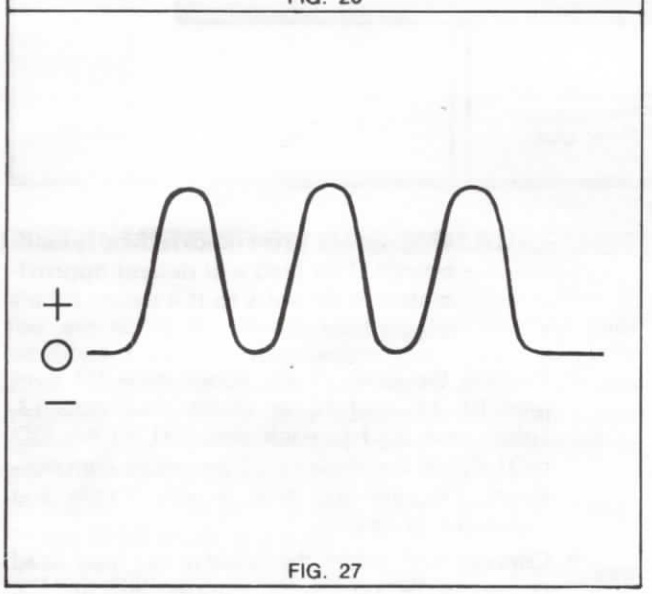


FIG. 27

HIGH VOLTAGE CIRCUIT EXPERIENCE

DISCUSSION

In the first stage construction, you saw the AC changed to DC and the voltage doubled. In this stage, you will increase this voltage even more by means of a transformer. The resulting high voltage will provide the energy to cause the xenon tube to flash.

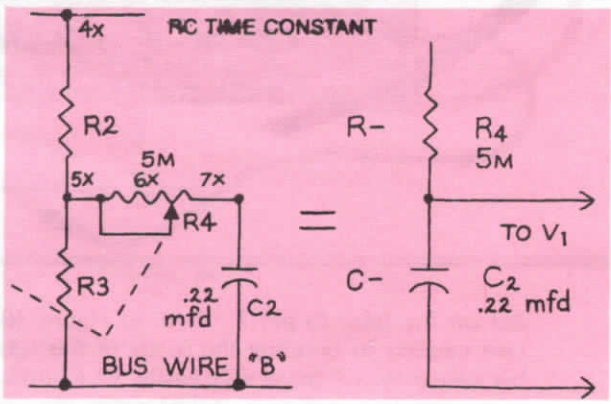
In this second stage, you will see three phenomena demonstrated: (1) time-constant charge and discharge of a capacitor, (2) ionization of a gas tube, and (3) voltage step-up by a transformer.

If, after the DC voltage was doubled in the first stage of construction, you applied it directly to the anode and cathode leads of the xenon tube V2, the tube would not light. Its internal gases must be ionized before it will conduct electron flow and only a high voltage will cause this ionization.

To achieve this high voltage, the following steps must take place. The voltage divider circuit that was formed by R2 and R3 breaks the DC into two parts. You place the voltage drop across R3 in a parallel circuit with R4 (a variable resistor) and C2; thus, you are able to control the rate at which C2 will charge. (This charging rate is called an "RC time constant".) When C2 charges to a pre-determined amount, the gases in the trigger tube V1 become ionized and, consequently current flows through the tube. (Refer to Figure 28.)

This conduction by V1 activates the primary winding of transformer T1. As a consequence, T1, by a process known as induction, steps up the voltage from the trigger tube to about 4000 volts.

When these 4000 volts strike the trigger lead of the xenon tube, its gases become ionized and, at the same time, the voltage that had been stored in the storage capacitor C3 from the voltage divider circuit is discharged into the tube. The duration of V2's flash will be only as long as the duration of C3's discharge.



WHEN: t=Time in seconds
R=Resistance in ohms
C=Capacitor in farads

t=5M (5,000,000) x .22 mfd (0.00000022)
or (5x10⁶) (.22 X 10^{-6}) =1.1 seconds
1.1 seconds is the time it takes to fire V_1

FIG. 28

CONSTRUCTION

____1. Separate six remaining pins from the soldering pin strips. Push a soldering pin into the breadboard panel at each of the remaining X marks on the schematic. (Refer to Figure 29.)

____2. Cut a 4-inch length of bus wire. This will form bus wire A. Connect this bus wire to pins 4, 9, and 10 as shown in Figure 29.

____3. Connect and solder the leads of the trigger capacitor C2, .22 mfd, 400 WV, to pin 7 and bus wire B. C2 will charge with DC voltage to a predetermined level, known as the ignition potential, and discharge to V1, ionizing its gases.

____4. Connect and solder the trigger tube V1 to pins 7 and 8. Connect the lead nearest to the white

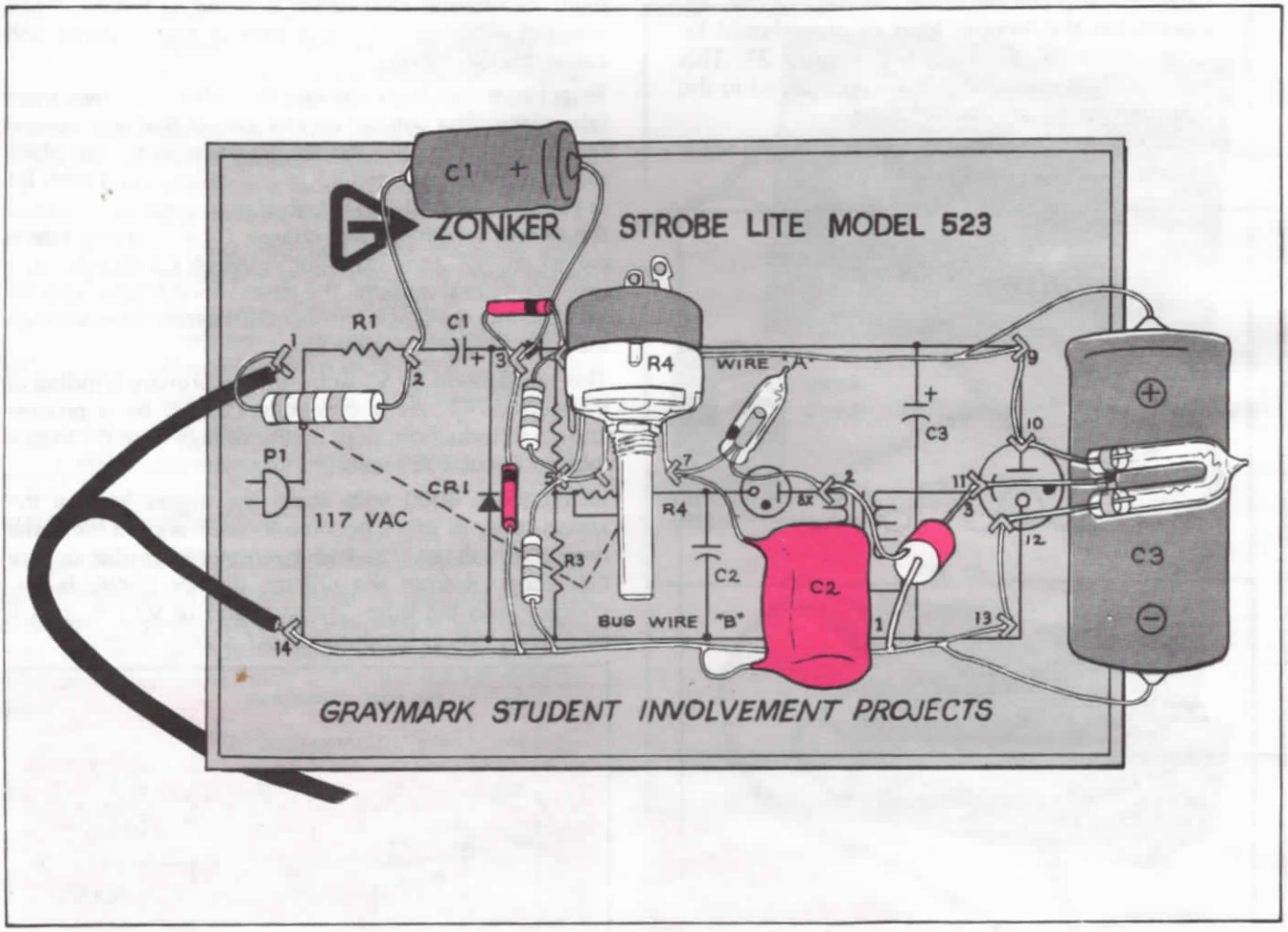


FIG. 29

dot on the tube to pin 7. (Refer to Figure 30.) Use caution in bending the leads of this tube because they will break very easily. V1 is similar to a neon lamp—that is, it will not ignite, nor fire, until a given voltage has been applied. The reason the tube will not fire at other voltages is that its internal gases must become ionized before it will conduct electron flow, and only a specific voltage will cause ionization.

____5. Cut a 1-inch length of bus wire and connect and solder it between pins 5 and 6.

____6. Carefully place the lugs A, B, and C of the pulse repetition control R4, 5 meg, potentiometer on top of pins 5, 6, and 7 as shown in Figure 31. Solder lug A to pin 5, lug B to pin 6, and lug C to pin 7. R4 is a variable resistor that will control the charging rate of C2, which will, as a result, control the flash rate of the xenon tube V2.

____7. Carefully bend the leads of the trigger transformer T1 (refer to Figure 32) and then:

____a. Connect and solder ground lead #1 to bus wire B.

____b. Connect and solder primary lead #2 to pin 8 (marked "WHITE" on breadboard)

____c. Connect and solder secondary lead #3 to pin 11 (marked red on breadboard). This lead will deliver approximately 4000 volts to the xenon tube's trigger lead.

____8. Position the leads of the xenon tube V2 over pins 10, 11, and 12 as shown in Figure 33. Solder one lead to each pin. CAUTION: DO NOT BEND the leads of V2 any more than necessary, because this tube is very fragile and expensive to replace.

____9. Connect and solder the positive (+) lead (lead nearest to "+") of the DC storage capacitor C3,

Connect and solder the other lead (-) to bus wire B. (Refer to Figure 29.) This capacitor stores a high potential charge across the xenon tube. When V2 is triggered, C3 discharges into the tube because a tremendous amount of energy is required the instant the tube's ionization takes place.

____10. This completes construction of your Zonker breadboard circuit. Check all soldered connections, component placement, and wiring and compare your breadboard to the illustration in Figure 29.

____11. Have your instructor initial your Progress Guide.

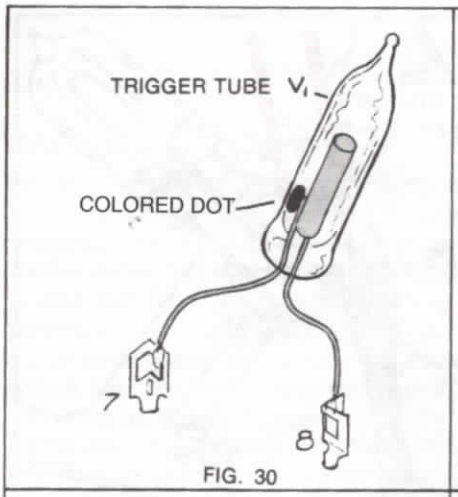


FIG. 30

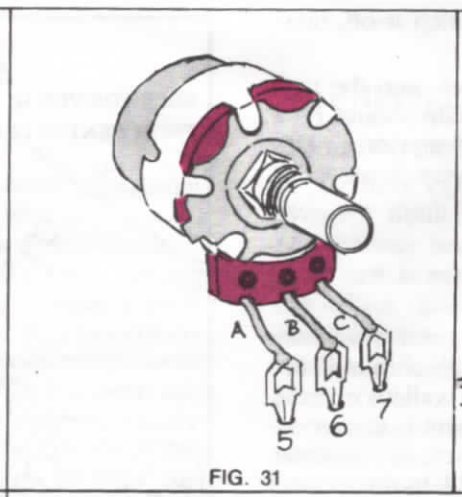


FIG. 31

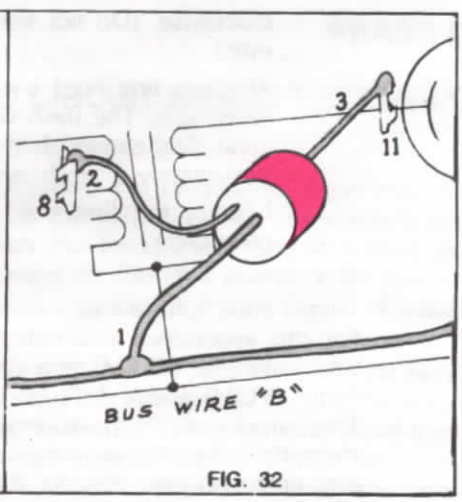


FIG. 32

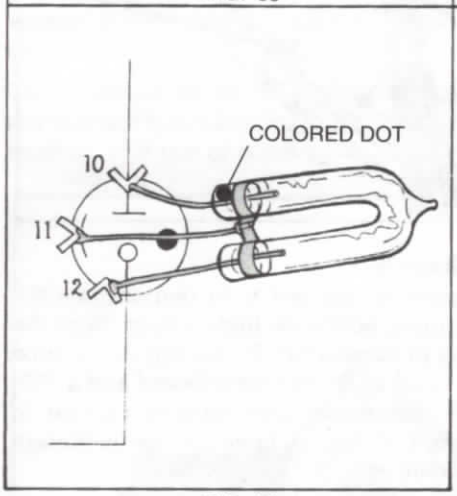


FIG. 33

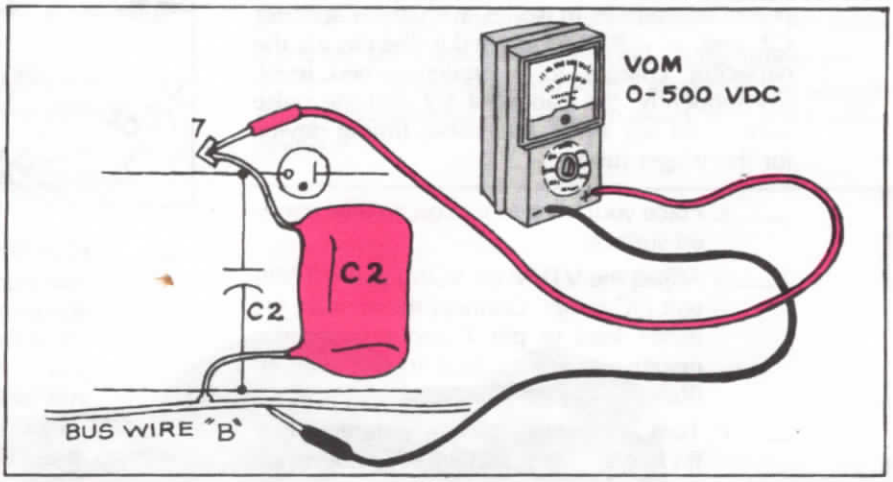


FIG. 34

INSTRUMENTATION AND MEASUREMENT

You are about to perform live voltage tests on your breadboard circuit. Remember that, when properly used, electricity is a useful servant of man, but when misused, electricity is very dangerous and can cause severe bodily harm. Therefore, always use care when working with electricity and observe these rules:

(1) Unplug circuit from power source BEFORE changing meter leads or wiring.

(2) Discharge the electrolytic capacitor C3 before changing meter leads or components.

CAUTION: A capacitor has the ability to store an electrical charge after power has been removed from the circuit. The larger the capacitor's capacitance value, the larger the electrical charge it can

charge to 300 volts and hold that charge until the xenon tube flashes. Even after the line cord has been removed from the wall receptacle, this voltage will be present across C3 for a period of time. Therefore, to prevent shock follow these steps in discharging the capacitors: (1) be sure the line cord is removed from the wall receptacle and (2) use an insulated, plastic-handled screwdriver to short across the capacitor leads.

(3) Stand on an ungrounded surface when working on and testing the breadboard circuit.

(4) If available, use an isolation transformer for added safety.

(5) Keep the breadboard on a wood or ungrounded surface when working on it and testing it. NEVER work on a metal surface.

(6) THINK SAFETY.

_____1. Breadboard Circuit Test

The purpose of this test is to determine if your Zonker breadboard is operating properly.

_____a. Turn the pulse control (pulse repetition control) potentiometer R4 fully clockwise.

_____b. Plug the AC line cord into a 117-volt wall receptacle. The xenon tube should begin to flash at a fast rate. If it does not, recheck all your connections and refer to the service flow chart on page 29.

_____c. Unplug the line cord from the wall receptacle.

_____d. Turn potentiometer R4 fully counter-

clockwise. (Do not switch it off, however.)

_____e. Plug the line cord back into the wall receptacle. The flash rate should be a great deal slower than previously (approximately 1 flash every 3 seconds).

_____f. Unplug the line cord from the wall receptacle.

_____2. Trigger Tube Voltage Measurement

For this experience you will need a vacuum tube voltmeter (VTVM) or a volt-ohm-milliammeter (VOM) and a 117-volt wall receptacle. The purpose of this measurement is to demonstrate the principles of resistance, capacitance, and time constant. Resistor R4 (pulse control potentiometer) is in series with the capacitor C2, and, as voltage is applied to the circuit, the capacitor charges to a predetermined level. Consequently, the capacitor C2 and the pulse control R4 act as an adjustable timing device for the trigger tube.

_____a. Place your breadboard on an ungrounded surface.

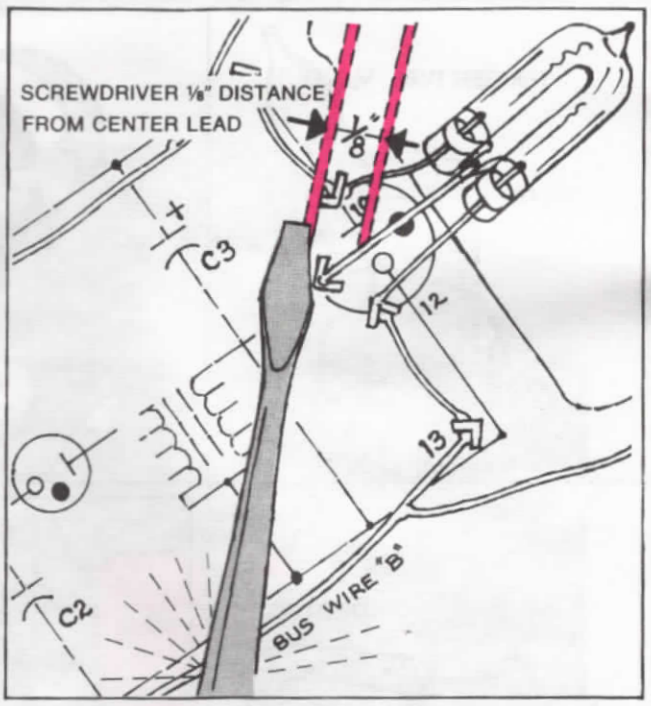
_____b. Adjust the VTVM (or VOM) to the 0-500 volt DC range. Connect the positive (+) meter lead to pin 7 and connect the negative (-) meter lead to bus wire B. (Refer to Figure 34.)

_____c. Turn the pulse control potentiometer R4 fully counterclockwise (do not switch it off, however) and then clockwise about ¼ turn, if a VTVM is used, or ½ turn, if a VOM is used.

_____d. Plug the line cord into a 117-volt wall receptacle. At this time, the tube V2 should begin to flash at a slow rate. If it does not, unplug the line cord, turn potentiometer R4 slightly clockwise, and reinsert the line cord. The meter will indicate a high amount of voltage at first, but, when the V2 flashes, the voltage will drop in half. This demonstrates the charging and discharging of capacitor C2. The charging of C2 to a predetermined level causes it to discharge through the trigger tube, which flashes the xenon tube. When this happens, the voltage will drop across C2 and it will recharge at a speed determined by the setting of R4. Record your maximum voltage reading:_____. Your reading should be approximately 230 volts. Record your minimum voltage reading _____. Your reading should be approximately 100 volts.

_____e. Unplug the line cord and remove the meter leads.

_____f. Using a screwdriver or a clip lead, discharge capacitor C3, as shown in Figure to eliminate a possible shock hazard



_____3. High Voltage Test

The purpose of this test is to demonstrate the spark-jumping action of high voltage from the secondary of transformer T1. For this experience, you will need only your breadboard and a 117-volt wall receptacle. Use extreme caution in performing this test, as large voltage is present in the circuit.

_____a. Rotate the pulse control potentiometer fully clockwise.

_____b. Plug the line cord of your Zonker into a 117-volt wall receptacle. The xenon tube should begin to flash.

_____c. Place the metal shaft of a plastic-handled screwdriver to pin 13 or bus wire B and move the tip of the screwdriver about ⅛ inch from the center lead of xenon tube. CAUTION: DO NOT LET YOUR HAND COME IN CONTACT WITH ANY WIRES OR COMPONENTS ON THE BREADBOARD. A spark should jump between the tube lead and the screwdriver. If it does not, move the tip of the screwdriver closer to the tube lead. (Refer to Figure 35.)

_____d. Unplug the line cord from the wall receptacle.

_____e. Discharge capacitor C3, using the plastic-handled screwdriver, as shown in Figure 21.

Voltage will jump between two points of different polarity approximately 1 inch per 20,000 volts. Therefore, since the secondary of the T1 transformer produces about 4000 volts, the spark should jump approximately ⅕ that amount, or about ⅛ inch.

_____4. Have your instructor initial your Progress Guide.

PRINTED CIRCUIT BOARD ASSEMBLY

DISCUSSION

Modern printed circuit technology offers substantial reductions in both size and weight over discrete hook-up wired circuits. Without the use of printed circuit boards, such engineering triumphs as the Apollo moon landing would not have been possible. Your Zonker uses a printed circuit board (PCB) that serves as a foundation for mounting and connecting the various components which form the unit's circuitry. Your PCB has been silk screened on the non-copper side to show you exactly where each component is mounted. The copper circuit side has a special flux coating, which protects the copper from oxidation and helps produce good solder connections.

The assembly of the PCB gives you an opportunity to develop skills in soldering, lead dress, component identification, and use of hand tools.

CONSTRUCTION EXPERIENCE

If you have completed the breadboard experience in Phase I, unsolder (by reheating the connections) the components from the breadboard, one at a time, as each part is needed for the PCB assembly. Be sure to use a heat sink on your diodes during the unsoldering and soldering processes.

All components and wires are mounted from the non-copper side of the PCB. Be sure to mount the components as close to the PCB as possible to avoid lead breakage and short circuits. After inserting the components or wire leads, bend the leads to hold the components in place until you are instructed to solder them.

All leads are soldered on the copper side, unless you're instructed otherwise. Wear safety glasses while unsoldering and soldering to avoid eye injury from a hot solder splash.

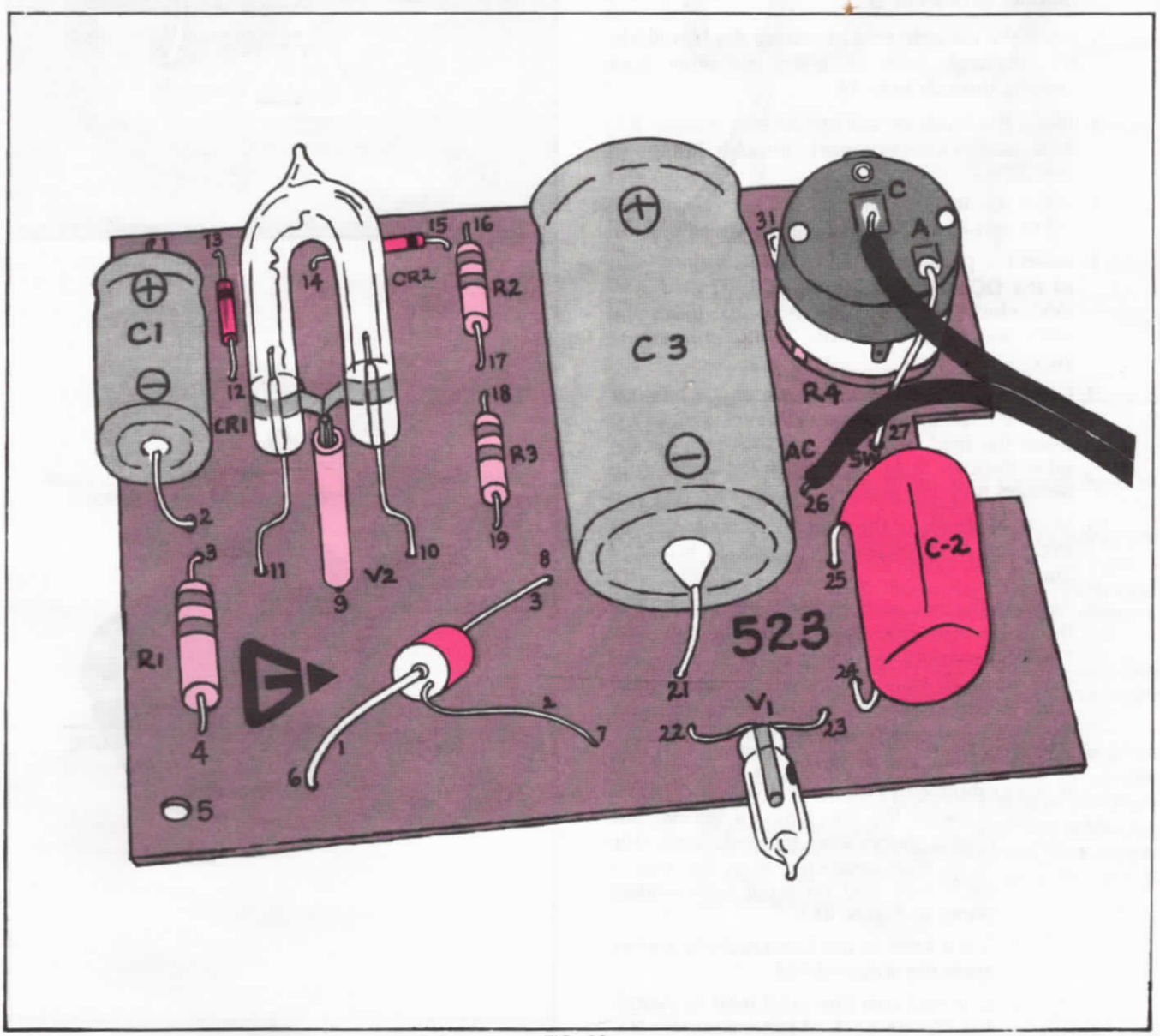


FIG. 36

____1. Insert the positive (+) lead (lead nearest to "+") of the voltage doubler capacitor C1, 2.2 mfd, 350 WV, electrolytic, through hole 1 of PCB. Insert the negative (-) lead through hole 2. (Refer to Figure 36.) Bend the leads to hold C1 in place.

____2. Insert the leads of the current-limiting resistor R1, 150 ohm, 2 watt through holes 3 and 4.

____3. Insert the leads of the trigger transformer T1 through holes 6, 7, and 8 as follows: (Refer to Figure 37.)

____a. Insert the ground lead #1 through Hole 6 (marked "BLK" on PCB).

____b. Insert the primary lead #2 through Hole 7 (marked "WHT" on PCB).

____c. Insert the secondary lead #3 through Hole 8 (marked "RED" on PCB).

____4. Insert the cathode lead (lead nearest to colored band, refer to Figure 38)of voltage doubler diode CR1 through hole 13. Insert the other lead (anode) through hole 12.

____5. Insert the cathode lead of voltage doubler diode CR2 through hole 15. Insert the other lead (anode) through hole 14.

____6. Insert the leads of voltage divider resistor R2, 47K (yellow-violet-orange), through holes 16, and 17.

____7. Insert the leads of voltage divider resistor R3, 2.2M (red-red-green), through holes 18 and 19.

____8. Insert the positive (+) lead (lead nearest to "+") of the DC storage capacitor C3, 22 mfd, 450 WV, electrolytic, through hole 20. Insert the other lead (-) through hole 21. (Refer to Figure 36.)

____9. Carefully bend the leads of the trigger tube V1 so they align themselves over holes 22 and 23. Insert the lead nearest to the white dot on the tube through hole 23. Insert the other lead through hole 22. (Refer to Figure 39.)

____10. Insert the leads of the trigger capacitor C2, .22 mfd, 400 WV, plastic film, through holes 24 and 25.

____11. Remove the nut and washer from the shaft of the pulse repetition control potentiometer R4. From the non-copper side of the PCB, insert the shaft through hole 28. Insert the other three leads through holes 29, 30, and 31 as shown in Figure 40. The middle lead must be in hole 30. Replace the nut and washer.

____12. If you completed Phase I, omit step a.

a. Separate the two leads of the AC line cord 2 inches from the end. Next, strip ¼ inch of insulation from the end of each lead and tin (coat with solder). (Refer to Figure 41.)

b. Tie a knot in the line cord 4½ inches from the stripped end.

c. Connect one line cord lead to switch lug "C" on back of potentiometer R4. (Refer to Figure 44.)

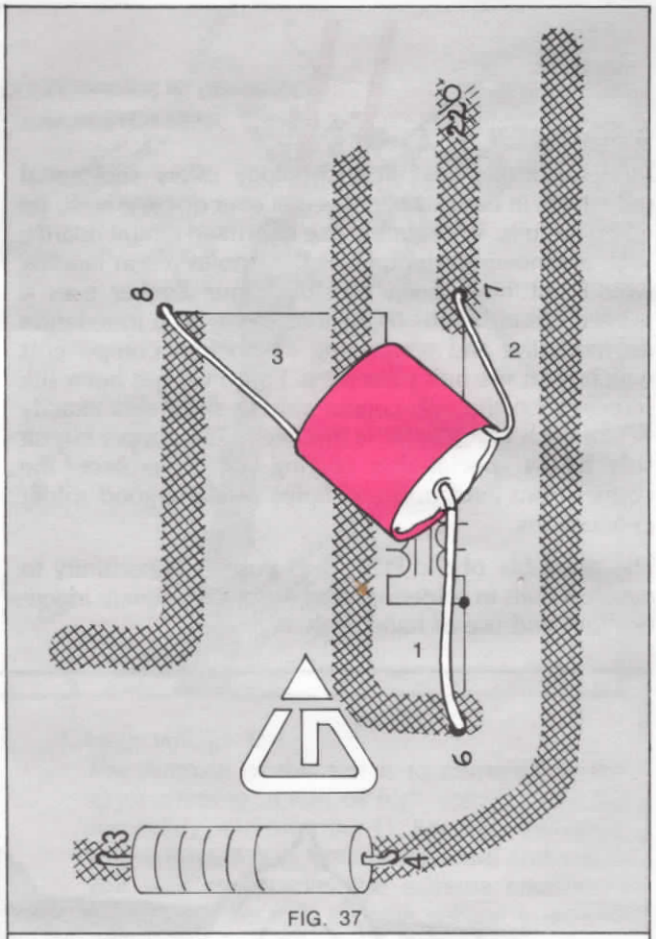


FIG. 37

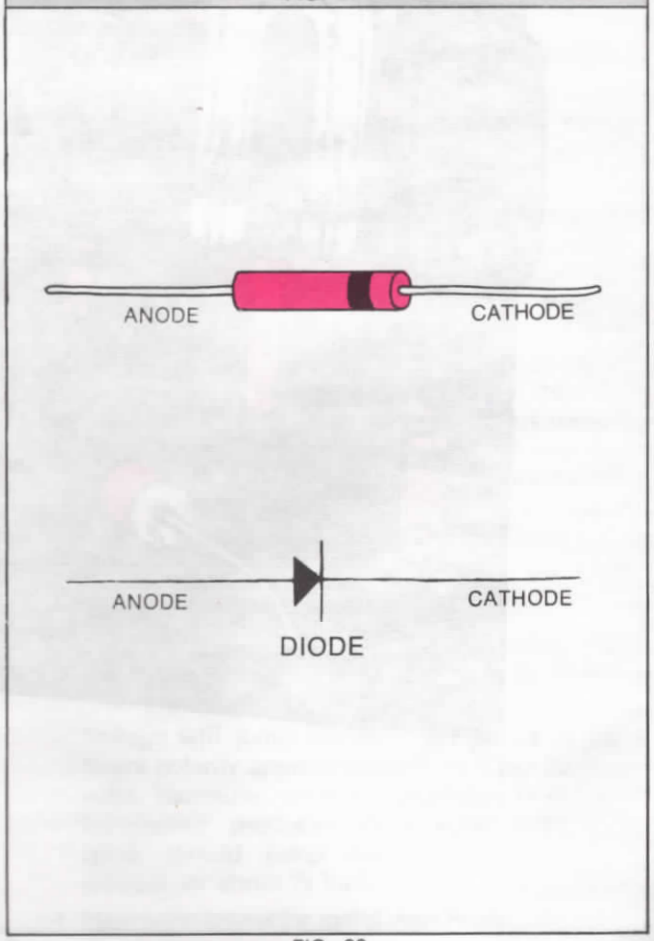


FIG. 38

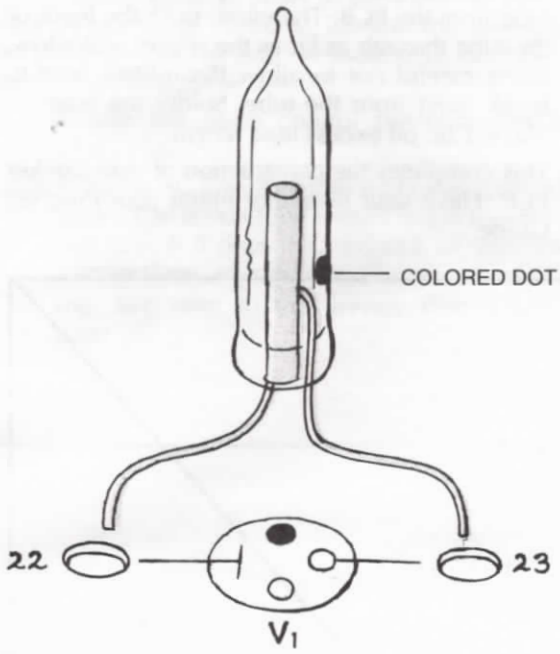


FIG. 39

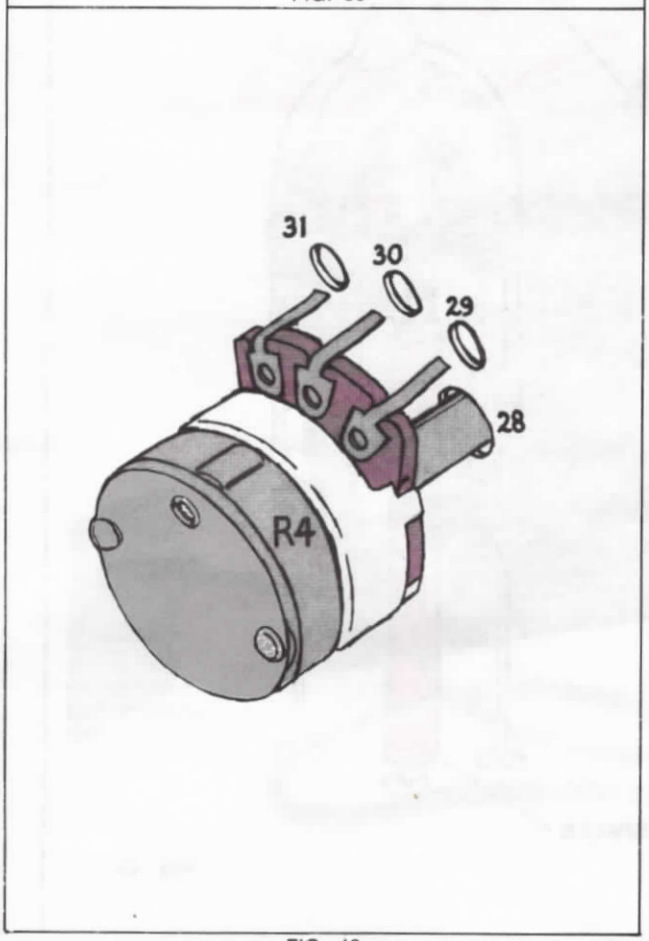
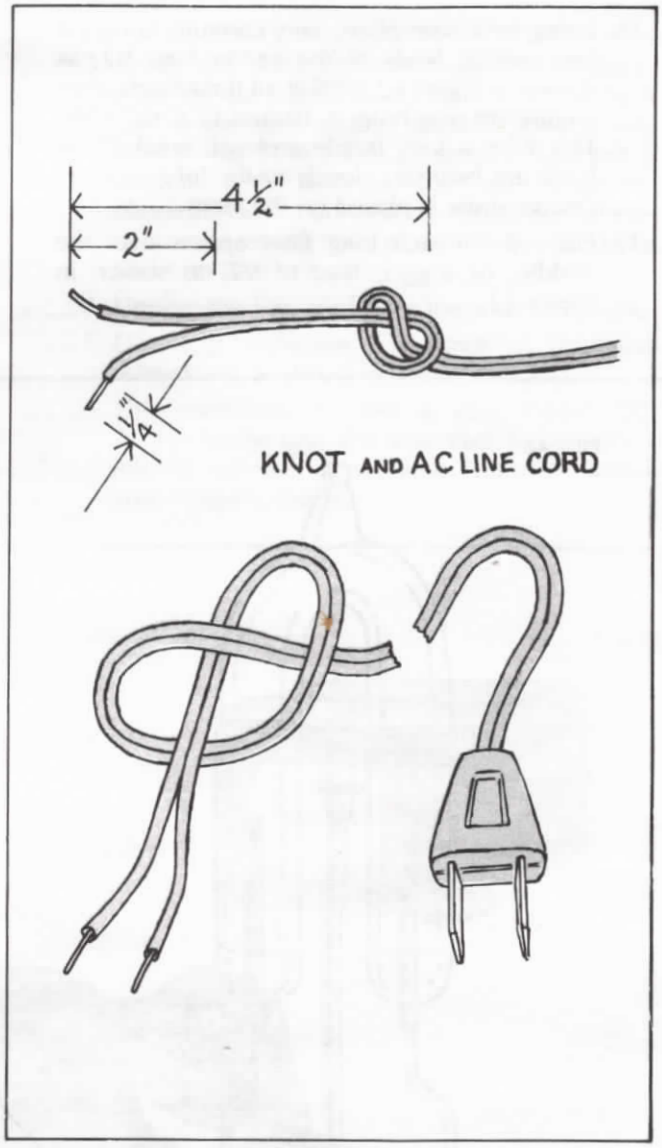


FIG. 40



_____d. Insert the other lead through hole 26 marked "AC" on the PCB.

____13. Cut a 2-inch length of bus wire. Connect one end of this wire to switch lug "A" on back of potentiometer R4. Insert the other end through hole 27 marked "SW" on the PCB. (Refer to Figure 44.)

____14. Check all components and wires to be sure they have been properly placed, as shown in Figure 36.

____15. Solder all wire leads on the copper side of the PCB. Use heat sinks when soldering the diodes. Your solder connections should look like those illustrated in Figure 11. Be sure that solder has not accidentally bridged between two copper islands. Cut off excess length of leads next to the solder connections.

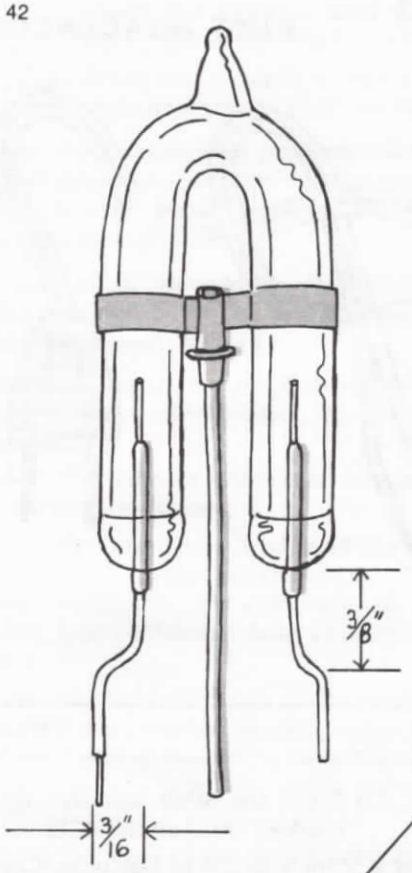
____16. Using long-nose pliers, *very carefully* bend the two outside leads of the xenon tube V2, as shown in Figure 42, so that all three leads align themselves over holes 9, 10, and 11. CAUTION: This tube is very fragile and will break if the leads are bent too closely to the tube or if excessive stress is placed on the leads.

____17. Place the 1-inch long fiber spacer over the middle, or trigger, lead of V2, as shown in Figure 43.

____18. Carefully insert the three leads of V2 through holes 9, 10, and 11. The fiber spacer on the middle lead determines the spacing of the xenon tube from the PCB. Therefore, push the leads of the tube through as far as the spacer will allow, being careful not to allow the middle lead to break apart from the tube. Solder the leads in place. Clip off excess lead length.

____19. This completes the construction of your Zonker PCB. Have your instructor initial your Progress Guide.

FIG. 42



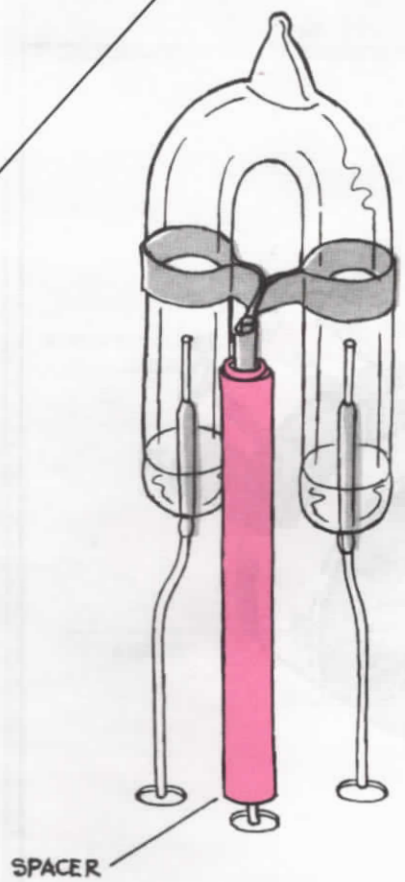


FIG. 43

CIRCUIT TEST

This experience will provide a live voltage test of your PCB-mounted circuit in order to demonstrate that your Zonker is operating properly. Review the safety rules under Instrumentation and Measurement on Page 19 before conducting these tests.

_____1. Rotate the pulse control potentiometer fully clockwise.

_____2. Plug the AC line cord into a 117-volt wall receptacle. The xenon tube should begin to flash at a fast rate. If it does not, recheck all your solder connections, component placement, and wiring, and refer to the Service Flow Chart on page 29.

_____3. Rotate the pulse control slowly counterclockwise (do not switch if off, however). The flash rate of the tube should begin to slow down, until it flashes at a rate of about 1 flash per 3 seconds. If the flash rate does not change, recheck all solder connections, component placement, and wiring and refer to the Service Flow Chart on page 29.

_____4. Unplug the line cord from the wall receptacle.

_____5. Discharge capacitor C3, using an insulated screwdriver, as shown in Figure 21.

_____6. This completes the test of your Model 523 Zonker Strobe Lite. It is now ready to be placed into its cabinet. Have your instructor initial your Progress Guide.

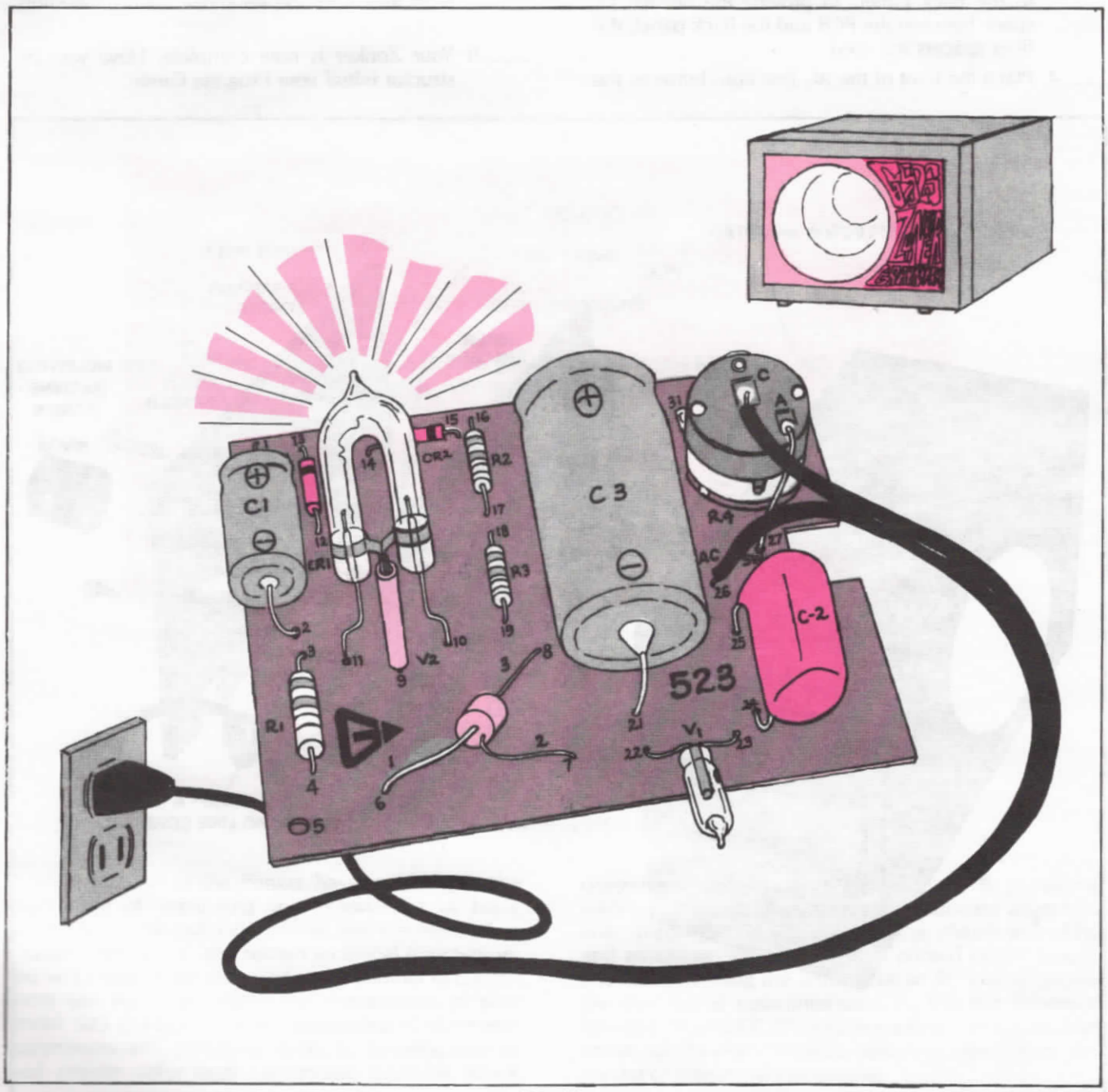


FIG. 44

CABINET ASSEMBLY

The plastic cabinet serves three specific functions: (1) encloses and protects the electronic circuitry, (2) provides convenient mounting area for controls, and (3) adds an aesthetic value to the product.

_____1. Insert the two round-headed machine screws through holes B and C of the rear panel as shown in Figure 45. Then, place the two 3/16-inch fiber spacers over the threaded portion of the machine screws.

_____2. Insert the metal shaft of the pulse control potentiometer through the hole in the rear panel labeled "A" in Figure 45. Carefully align the two machine screws with holes 5 and 32 of the PCB and insert.

_____3. With the machine screw nuts, secure the PCB to the back panel. To provide the needed air space between the PCB and the back panel, the fiber spacers are used.

_____4. Place the knot of the AC line cord between the PCB and the back panel and allow the cord to rest in the line cord opening.

_____5. Carefully insert the entire assembly into the cabinet so as to avoid damage to the xenon tube, which is inserted through the opening in the reflector. CAUTION: If the xenon tube will not slide into the reflector opening, do not force it. Realign the tube by bending the leads slightly and then try inserting the assembly again.

_____6. With the back panel assembly housed in the cabinet, use the two self-tapping screws and insert them through holes D and E. (Refer to Figure 45.) Secure the back panel to the cabinet.

_____7. Place the control knob over the pulse control shaft and, with the set screw, secure the knob.

_____8. Your Zonker is now complete. Have your instructor initial your Progress Guide.

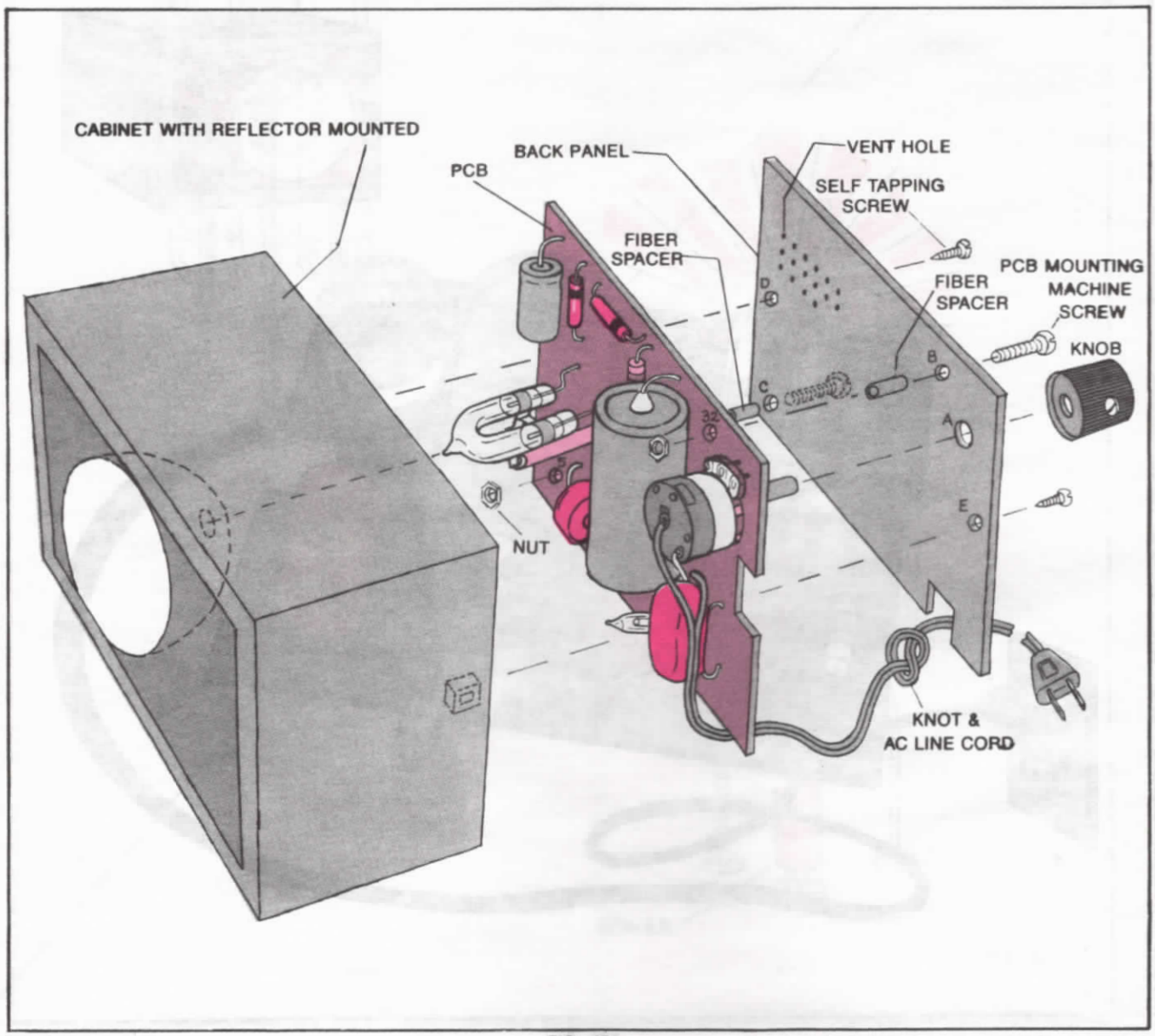


FIG. 45

PRODUCT OPERATION

The assembly and circuit test of your Model 523 Zonker are completed. To obtain maximum operating results from your unit, follow these instructions and suggestions.

The Zonker is designed to work anywhere that a standard 117-volt receptacle is available. You do not need any added components to enjoy your Zonker; however, some mood music will enhance its performance.

For best display effectiveness, the lighting in the room in which the Zonker is used should be dim; the Zonker's use in a totally darkened room will give fascinating effects. The rate of pulsing of the xenon tube can be varied from one pulse every few seconds to four or five every second. To get this variation, simply turn the pulse control knob.

The Zonker has a multitude of uses, such as at parties and psychedelic happenings, for photography, and as a warning device.

To preserve the life of the xenon tube, use the Zonker for only 30 minutes at a time, with a 5-minute rest period before reuse. Caution: Do not look directly at the flashing xenon tube for long periods of time, because it may cause eye injury.

SPECIFICATIONS

POWER REQUIREMENT: 110-120 volts AC, 50-60 Hz

FLASH CONTROL SPEED: 1-5 flashes per second

XENON TUBE SPECIFICATIONS: gas filled; 300 V anode voltage, 4KV trigger voltage; 1.8 watt seconds maximum energy input (watt sec. $=\frac{CV^2}{2}$)

XENON TUBE FLASH LIFE: 500,000 flashes

SEMICONDUCTORS: two silicon diodes, 400 PIV, 600 mA

LEARNING EXPERIENCE REVIEW

The construction of the Zonker has provided you the opportunity of expanding your knowledge of basic electronics, semiconductor devices, and gas-filled tubes through experiences and related technical information. You will probably be surprised at the number of experiences you have had during the construction of your Model 523 Zonker, such as: Identifying of electronic components and schematic symbols; learning how to read resistor color code, schematic diagrams, block diagrams, and component layout on a PCB; practicing soldering, the use of heat sinks, breadboard assembly, wire stripping and tinning, lead dress, chassis assembly, and mounting components on a printed circuit board; and understanding the purpose of an RC timing circuit, the workings of a gas-filled tube (V1, V2), the difference between AC and DC, transformer action, voltage doubler action, diode characteristics, potentiometer action, capacitor charging and discharging.

REVIEW EVALUATION

The review evaluation is an important part of your instruction manual. It allows you to gauge how well you have mastered certain basic electronic principles as they relate to your 523 Zonker.

TRUE OR FALSE: Mark the following statements T for true and F for false by circling the correct letter.

T F 1. The voltage that is applied to the xenon tube trigger lead (center lead), in order to ionize the gases in the tube, is 117 volts AC.

T F 2. The purpose of the trigger transformer T1 is to step up the low DC voltage for triggering the tube V2.

T F 3. The function of the 22 mfd capacitor C3 is to create a high DC level on the anode and cathode of V2 by obtaining an electrical charge from the doubler circuit and by discharging that voltage through the xenon flash tube.

T F 4. The pulse control (R4) and capacitor C2 function in the circuit as an adjustable time control.

T F 5. The purpose of diodes CR1 and CR2 is to rectify DC and double the AC voltage.

T F 6. The xenon tube V2 has three leads: anode, emitter, and base.

T F 7. The color code for a 47K resistor is yellow-violet-orange.

T F 8. The colored band on a diode represents the cathode lead.

T F 9. You do not need to use a heat sink when soldering diode leads.

T F 10. The red lead on the trigger transformer T1 is the secondary, or trigger, lead.

MATCHING: In the space provided, place the correct letter that matches the schematic symbol from the column on the right.

____1. POTENTIOMETER

____2. ELECTROLYTIC CAPACITOR

____3. RESISTOR

____4. DIODE

____5. TRIGGER TUBE

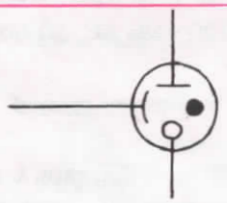
____6. TRANSFORMER

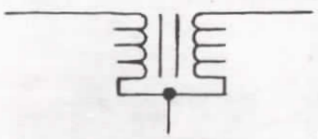
____7. CAPACITOR

____8. XENON TUBE

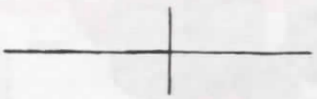
____9. ELECTRICAL CONNECTION

____10. NO CONNECTION

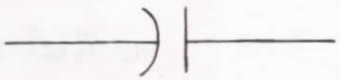
A. 

B. 

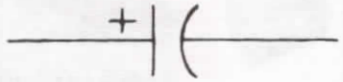
C. 

D. 

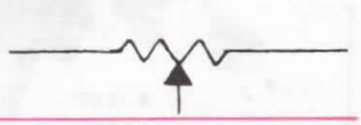
E. 

F. 

G. 

H. 

I. 

E. 

COMPLETION: Fill in the missing word or words to make the statement correct.

1. To protect solid state devices from damage from overheating you must use a_____.
2. A diode will allow_____ flow in only one direction.
3. The purpose of the high voltage that is applied to the trigger lead (center lead) of the xenon tube V2 is to_____.
4. The step up characteristic of a transformer is technically called_____.
5. A diode has two leads, one of which is positive, the other negative. These two leads are called, respectively,_____and_____.

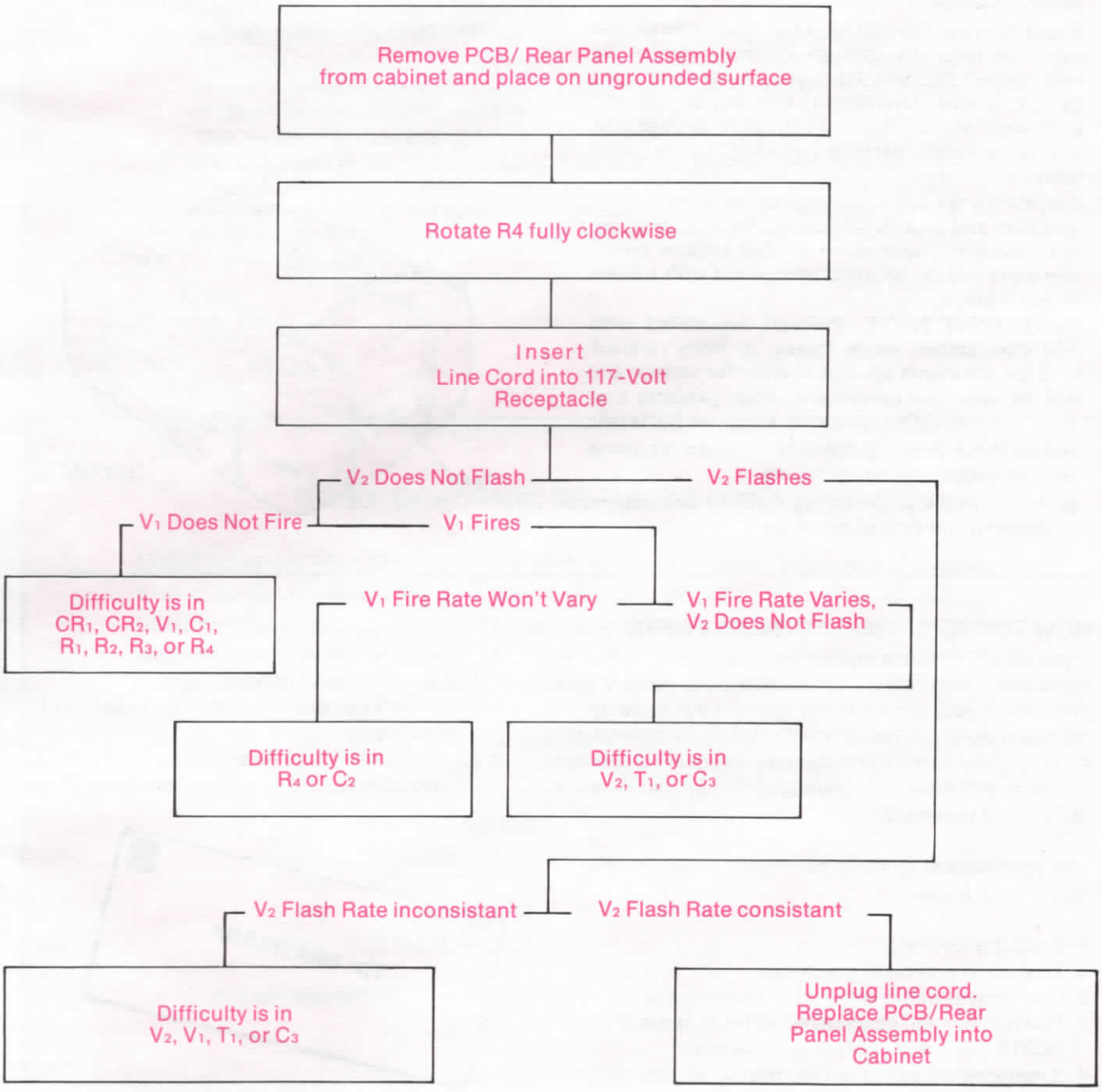
When you have completed this Evaluation Review, have your instructor initial your Progress Guide.

SERVICE AND PARTS REPLACEMENT

SERVICE FLOW CHART

In the event your Model 523 Zonker requires servicing, use the *Service Flow Chart* to aid in locating the problem. Before using the flow chart, be sure items 1 through 4 are confirmed.

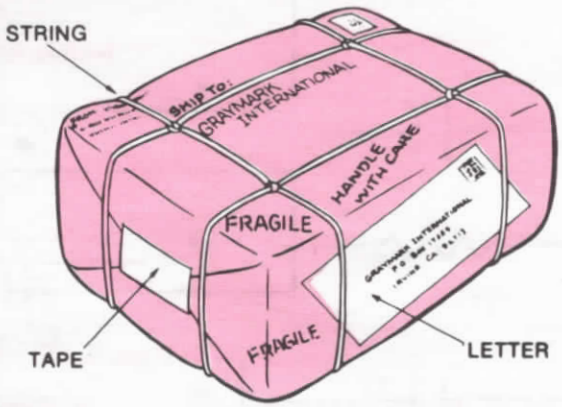
1. Check all solder connections. Poorly soldered connections must be reheated to form good, shiny joints. (Refer to Figure 11.)
2. Check the placement of all components and wire leads as shown in Figure 29 or 36.
3. Be sure that solder has not accidentally bridged between two copper islands.
4. Be sure that clipped component leads have not lodged under the components to form shorts or mis-connections.



FACTORY SERVICING

If the completed project does not operate properly and you can find no wiring errors or defective components, write to our Service Department and request technical assistance. This service assistance is available to you at no charge. However, before you write, be sure you have reviewed each stage of construction and followed steps outlined in the SERVICE FLOW CHART

1. When writing, give a full description of the trouble, indicating which sections of the circuit you have tested according to the instructions in the Service Flow Chart. In most cases, our service consultant can determine from your letter the probable cause of trouble and assist you in repairing the project yourself . . . saving you time and service expense.
2. If our Service Consultant cannot determine the cause of difficulty through correspondence, he will suggest that you have your project repaired by our Service Department. You will be charged a minimal service fee of $5.00, plus postage and any replacement parts not covered by the warranty.
3. Graymark's Service Department is primarily for inspection and trouble-shooting. Projects that are not completely assembled or that require extensive work will be returned unrepaired with a letter of explanation.
   IMPORTANT NOTE: Projects assembled with acid core solder, paste fluxes, or irons cleaned with sal ammonia are not eligible for service and will be returned unrepaired. Also, projects that have been modified won't be accepted for repair.
4. Follow these shipping instructions when returning your project for factory servicing:
   a) Attach to the project a tag that lists your name, address, and date of purchase.
   b) Be sure that all parts and fittings are attached to the project.
   c) Pack the project in a strong carton and place at least 3 inches of packing material, such as shredded paper or excelsior, between all sides of the projec and the carton.
   d) Seal the carton with gummed tape and tie with a heavy string. Write FRAGILE, HANDLE WITH CARE on several sides of the carton.
   e) Print clearly your name and return address in the upper left-hand corner of the carton. Print in large letters the address on the back cover.
   f) Attach a letter to the outside of the carton containing your name, address, date of purchase, and a brief description of the product's difficulty.
   g) Ship by insured parcel post.



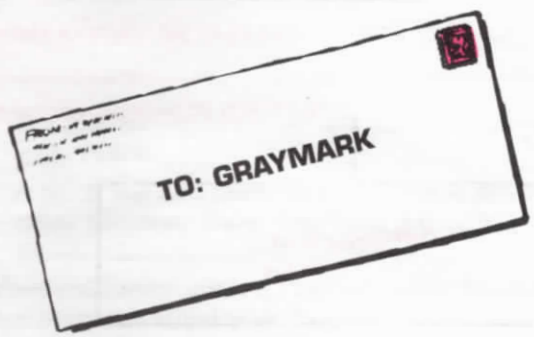
HOW TO ORDER REPLACEMENT PARTS

If you should require a replacement part, please follow the instructions listed below. Replacement parts will be shipped promptly to you, subject to the terms of the warranty. Do not return the original component or fitting unless requested to do so. Graymark's warranty does not cover components or fittings that have been damaged through carelessness or incorrect assembly.

Mail your request for replacement part to the address on the back cover.

Enclose the following:

1. Your name and mailing address.
2. Date project was purchased.
3. Part number and description (as listed in the PARTS LIST of the part to be replaced.
4. If replacement part is not covered by the warranty you must:
   a. List replacement cost as shown.
   b. Add $1.00 to cover handling costs.
   c. If you are a California resident, add sales tax to total purchase.
   d. Enclose your money order or check for the full amount. Sorry, C.O.D. not accepted.



FACTORY WARRANTY

GRAYMARK INTERNATIONAL, INC.

Graymark International, Inc. warrants that each project was complete and ready to assemble at the time of shipment. All shortage claims must be made within 10 days from receipt of goods representing each project. Graymark warrants that, for a period of ninety (90) days from date of purchase, all merchandise is free of defects in material and workmanship, under normal conditions of use and service. The obligation of Graymark under this warranty is limited to repair or replacement of those parts upon verification that they are defective in this manner. Graymark's obligation does not include labor required to service or repair any project.

This warranty is completely void and Graymark will not repair, replace, or service any project or parts thereof on which acid core solder, paste flux, or corrosive solders have been used in assembling the project. Any modification of the project will void the warranty.

This warranty is extended solely to the original buyer and only to the extent above expressed. No dealer or agent is authorized to make any other or additional guarantee or warranty. In no event shall Graymark be liable for any anticipated profits, consequential damage, loss of time, or other losses incurred by the buyer in connection with the purchase, assembly, or use of the project or components thereof.

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ADDENDUM FOR THE 523 STROBE LIGHT

This addendum is for the April 1977 revision of the Model 523 ZONKER Strobe Light Manual (P/N 61929). Read through this first, and make the proper changes.

1) A new Knob (P/N 62555) replaces the old Knob (P/N 61548). A new Spacer (P/N 61259) replaces the old Spacer (P/N 61469).

2) The Potentiometer with AC Switch (P/N 61486) at R4 has been replaced with a Potentiometer which has no Switch (P/N 62808). The AC Line Cord (P/N 61620) has been replaced by AC Line Cord with Switch (P/N 63964). Before starting the construction of the Kit, cut three 1" lengths of Bus Wire and solder them to each of the three terminals on the Potentiometer.

3) A 22 Ohm, 5%, 1/2 Watt (P/N 61390) Resistor R5 has been added to the circuit in series between the Trigger Tube V1 and lead #2 of the Trigger Transformer.

   When building the Breadboard, perform the following Step after Step 6 on Page 18:

   __6a. Solder one lead of the 22 Ohm Resistor R5 to Pin 8.

   At Step 7b on Page 18, perform the following:

   __7b. Connect and solder the Primary lead #2 to the free end of R5.

   When building the PCB, perform the following Step after Step 2 on Page 22:

   __2a. Bend one lead of the 22 Ohm Resistor R5 at right angle and install into the PCB at Hole 7.

   __2b. Solder that lead and cut off any excess lead length.

   __2c. Bend the free lead of R5 into a U-shape about 1/4" long.

   At Step 3b on Page 22, perform the following:

   __3b. Connect and solder the Primary lead #2 to the free end of R5. Cut off any excess lead length.

4) At Page 22 perform the following Steps 12d & 13 instead of the ones in the manual. Skip over Step 12c:

   __12d. Insert one Line Cord lead into the PCB at Hole 26 marked AC.

   __13. Insert the second Line Cord lead into the PCB at Hole 27 marked SW.

5) At Step 3 on Page 26, perform the following:

   __ 3. Using the Machine Screws, Nuts and Shoulder Washers, mount the PCB to the Back Panel. The narrow end of the Shoulder Washers must face toward the Panel, NOT the PCB.